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BIRMINGHAM

AND

MIDLAND HARDWARE

DISTRICT.

THE
RESOURCES, PRODUCTS,
AND
INDUSTRIAL HISTORY
OF
BIRMINGHAM
AND THE
MIDLAND HARDWARE DISTRICT:

A SERIES OF REPORTS,

COLLECTED BY THE LOCAL INDUSTRIES COMMITTEE OF THE
BRITISH ASSOCIATION AT BIRMINGHAM, IN 1865.

EDITED BY
SAMUEL TIMMINS.

LONDON:
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1866.

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BRITISH ASSOCIATION.

MEETING AT BIRMINGHAM, 1865.

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EDITOR'S PREFACE.

THE Meeting of the British Association at Birmingham, in 1865, led to the formation of a Local Industries Committee, for the purpose of compiling a series of Reports on the numerous and varied products of the Midland Hardware District, of which Birmingham is the most important and, practically, the central town. The list of the Committee is given on the previous page, and the result of their labours is now presented in the following work.

The trades are so numerous, so infinitely various, and conducted by so many different persons, that it has been found impossible to do full justice to all, or even to mention all the names and branches which extend over Birmingham alone. The Chairman and the two Secretaries, however, applied to the persons most competent to furnish information, or to prepare a report, and their proposals were favourably received, and generally with satisfactory results. A Sub-Committee for the Chemical, and another for the Mechanical Trades, was appointed, and the results of their labours are included in the following pages, not always under one head but throughout the volume, as the partial classification required.

Every effort was made in each department to obtain statistics of the production, workpeople, wages, prices, raw material, &c., but with a few honourable exceptions the necessary information was withheld, although only the aggregate results would have been given, the details being seen by the Chairman alone.

The volume may fail in giving an adequate idea of the extent and variety of our local trades, but it will have done something to show that within a radius of thirty miles of Birmingham nearly the whole of the hardware wants of the world are practically supplied. The coal and iron of Staffordshire—the chemical products, glass and alkalis and soap of Smethwick—the metal works in infinite variety which Birmingham produces, from the costliest plate and jewellery down to the commonest gilt toys—the engines and machinery of every description exported to all parts of the world—every class of article being produced, from the very cheapest to the very best—can be only imperfectly described even in the seven hundred pages of this work.

These reports make no pretension to literary merit. They have been written, collected, compiled, and edited by those who are busily engaged in the trade-life of the town. The whole of the matter is original, and the difficulties encountered have been almost insuperable, no such work having been attempted before. The aim has been to describe the "Date of introduction and early history, the obsolete articles, the curiosities and oddities, the new varieties, the increase since 1849, the effects of the spread of civilisation on the supply of raw material, the new processes, the machine or hand-labour, the employment of women and children, the effects of improvements on cost, the home and foreign trade, the effects of the French Treaty and the American war, the other seats of manufacture, the numbers employed, the average earnings, and the general condition of the workpeople," as relating to every principal trade in the town and district. Although this task may not have been accomplished so completely as was originally hoped, it will be found that, at least, a large and important mass of industrial facts have been collected and preserved.

The hearty thanks of the Committee are due to those gentlemen who have contributed the various papers which bear their names, and to Mr. John Jones, F.G.S., of Dudley, for the great ability and industry he has devoted to the collection of the District portion of this work. To Mr. W. C. Aitken, the especial thanks of the Editor and every reader are emphatically due, for the readiness with which he has supplied reports which could not be obtained elsewhere. For twenty years Mr. Aitken has devoted his large technical knowledge and artistic skill to the study and improvement of nearly every branch of Birmingham Art-manufacture, and he has freely given his untiring services, even at a few hours' notice, to complete any portion of the work where some other contributor had failed.

From the Honorary Secretaries, Mr. William Kenrick, and Mr. R. F. Martineau, much valuable information and help has been received; and to Mr. Sebastian Evans, M.A., the Editor's thanks are specially due for most valuable assistance in the heavy labour of editing so large and elaborate a work.

The volume has not only been written in Birmingham, but printed here by Messrs. Billing, Son, & Co., and will, it is hoped, be found not unworthy of the town in which Baskerville's unrivalled works were produced. At the request of the Editor, Mr. John Hardman Powell gave the design for the cover, at a very short notice, and the die was cut at Messrs. John Hardman and Co.'s Works.

The local efforts have been amply supported by Mr. Robert Hardwicke, whose liberality and good taste have greatly added to the appearance of the volume.

In conclusion, the Editor may be allowed to express an earnest hope that any additions or corrections may be forwarded to him, as he is fully conscious that many omissions and errors must have occurred during the progress of the work.

Elvetham Lodge, Birmingham,
August 15th, 1866.

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SKETCH OF THE GEOLOGICAL STRUCTURE OF THE SOUTH STAFFORDSHIRE COALFIELD.

BY J. BEETE JUKES, M.A., F.R.S., &c.

PARTS of the southern portion of this coalfield are in Worcestershire, and a portion round Hales Owen forms an isolated part of Shropshire, but the greater part is in Staffordshire.

Its northern apex is at Brereton, near Rugeley. Its southern margin extends from the parish of Harborne, near Birmingham, to that of Hagley, near Stourbridge. Its length from N. to S. is about 23 miles, its mean width from E. to W. being about 6 miles, and its area accordingly about 120 or 130 square miles.

A part of the main watershed of England, which here separates the basins of the Severn and the Trent, runs through this district from Bromsgrove Lickey Hill over Frankley Beeches, Lappal, and the Quinton, by Rowley Regis, Dudley, and Sedgley, to Wolverhampton. It would, I think, be possible to draw a line through those places, no point of which would traverse ground of a less height than 600 feet above the sea. About 2 miles to the N.N.W. of Wolverhampton, however, there is a depression or gap in this watershed, through which the Staffordshire and Worcestershire canal has been brought from one river basin to the other. The level of the canal there is 340 feet above the sea. This gap is at the Autherley junction, and it runs between the high land of Oxley and Bushbury on the one hand and that of Autherley and Tettenhall on the other, and may not improbably be the lowest connecting gap to be found between these two great basins of drainage in the midland counties. The little river Smestow rises on the south side of this gap, a tributary of the Stour which falls into the Severn at Stourport, and on the north side the river Penk, which joins the Sow* near Stafford; the Sow falling into the Trent near Great Haywood.

From Wolverhampton a secondary line of watershed runs by Wednesfield and Bushbury to Essington, Essington Wood, Pelsall Wood, and the Brown Hills, separating the basin of the Penk from that of the Tame, which are both tributaries of the Trent.

From the Brown Hills the high land of Cannock Chase runs northwards to Brereton, part of it being occupied by the northern corner of the coalfield, while to the south of that the coalfield is divided by the main watershed into two principal portions, that of the Tame Valley, between Dudley and Walsall, of which Bilston, Darlaston, and Wednesbury are the centres; and that of the Stour Valley, between Dudley and Stourbridge, of which Brierley Hill, Netherton, and Hales Owen are the chief places.

Having thus indicated the general form of the surface of the district, we will next examine the underground structure.

Rocks entering into the Structure of the District.—The aqueous or stratified rocks of which the district is composed, were formed during four different geological periods, namely, the Upper Silurian, the Carboniferous, the Permian, and the Triassic. The Igneous rocks belong all to the same class, that of the Basalts or Dolerites, though they have two or three distinct varieties of that class. The period of their formation may, perhaps, admit of some question, but I believe they were all formed during the Carboniferous Period.

It is important to note not only the formation of the rocks, during these four geological periods, but also the destruction of rock that took place in the intervals between those periods. This is not a merely theoretical speculation, but a fact which can be demonstrated, and the practical consequences of which are of the highest importance.

1.—The Upper Silurian Rocks.—These beds may be grouped as—

1c.—The *Ludlow Rocks*, including the Sedgley or brown limestone.

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* The Sow means the Sough or sewer, and is, therefore, synonymous with the Suir river in Ireland. "Tough" is often pronounced so as to rhyme with "cow" in the Staffordshire coalfield.

1B.—The *Dudley* or *Wenlock Rocks*, including the Dudley or white limestones, and the Hay Head limestone of Barr.

1A.—The *Llandovery Sandstone*, the top of which only is just seen in one or two places, except at the Lickey Hill, where it is converted into quartzite.

1A.—The *Llandovery Sandstone*, near Barr, is a yellowish brown or white sandstone, not very hard, which might, perhaps, if opened out, make a good building stone. In some places it is full of fossils, among which are the *Pentamerus lens*, and other characteristic Llandovery forms.

1B.—The *Dudley* or *Wenlock Rocks*.—These are chiefly grey sandy shales, sometimes greenish, sometimes bluish grey, locally called "bavin." In this there occur bands of limestone, usually flaggy and concretionary, sometimes swelling out into thick crystalline limestones. The lowest of these limestone bands is that of Hay Head, near Barr, which is believed to be the same as the limestone which occurs next above the Llandovery sandstone at Woolhope, in Herefordshire.

At Hay Head this limestone dips at 8° or 10° towards the west, in which direction no other rock but shale is seen till we reach Walsall, a distance of nearly two miles. We there come on another band of limestone, likewise dipping west at 8° or 10°, which was largely quarried formerly, while still farther west the cutting in the railroad disclosed a third calcareous band, also dipping west.

These Walsall limestones are the same as the Dudley limestones, for they have been sunk to, and worked at, several intermediate points between the two places. If we suppose that the shales between the Walsall limestone and that of Hay Head dip west at a mean angle of 5°, and that the distance between the two limestones is 10,000 feet, the thickness of the shale between them would be 870 feet.

The limestones of Walsall and Dudley are also the same as that of Wenlock, in Shropshire.

At Dudley there are two principal limestones, the upper about thirty feet thick and the lower about forty feet, with about ninety feet of shale between them. Near Dudley they show themselves in three irregular and broken elliptical elevations, known as the Castle Hills, the Wren's Nest, and

Hurst Hill; the beds rising steeply up from under the surrounding Coal-measures.

At Hurst Hill the *quâ-quâ-versal* dip of the limestones is interrupted on the western side, the beds being cut off by a fault which was traced in the underground workings and found to be a down-throw to the west. The beds to the west of Hurst Hill are therefore higher beds than those worked there.

1c.—*The Ludlow Rocks.*—Proceeding westward we meet with the outcrop of the Sedgley or brown limestone at a distance of about one-third of a mile from the white limestone of Hurst Hill. This Sedgley limestone dips at first to the west at about 10° or 20°, and if the same dip occurs in the shale below for even a quarter of a mile, that shale must have a thickness of at least 300 feet. The real thickness between the Sedgley and Dudley limestones, however, is probably much greater, as on Wenlock Edge it is, according to the Geological Survey sections (sheets, 33, &c.), at least 1,000 feet.

The Sedgley limestone forms a small shallow basin on the top of the ridge, in the hollow of which some Coal-measure sandstones repose. This limestone and its associated shale shows itself again at Turner's Hill, near Lower Gornal, and at the Hayes, about two miles east of Stourbridge, in consequence of a local tilting up of the beds and the removal of the Coal-measures by denudation.

The fossils found in the Dudley and Sedgley limestones are too well known to need more than a passing mention, though it must be acknowledged that no complete lists of those which have been found at the different localities have yet been made.

Interval between the Period of Formation of the Upper Silurian Rocks and that of the Coal-Measures.—There is not shown anywhere in this district a thickness of more than a few feet of shale above the Sedgley limestone, to represent the five or six hundred feet of Upper Ludlow rock, which lies above the Aymestrey limestone in Shropshire and Herefordshire. Equally unrepresented are all the Red Sandstones, which have been called "Tilestones," by Sir R. I. Murchison, and included as the uppermost Silurian beds, and the still greater thickness which has been assigned to the Old Red Sandstone in South Wales. Neither have we in this district anything to represent the Carboniferous Limestone and its associated beds of Lower Limestone shale, as in South Wales, or Upper Limestone shale, as in North Staffordshire and Derbyshire, the Yoredale rocks of Professor Phillips, or the Millstone Grit series of Farey and other authors.

The most probable supposition respecting the state of the district, therefore, during those periods is, that the waters in which those beds were formed did not prevail over this area—in other words, that it was dry land during that time. In support of this hypothesis may be urged the certain fact, that during part of that time the previously formed rocks were being wasted and destroyed, and this destruction can only be produced by the action of the surface of the sea on the margin of the land, or by the atmospheric agency of rain and rivers, which can, of course, only act upon rocks which are above the level of the sea.

No geologist could doubt that the Ludlow rocks, with the Sedgley limestone, once spread further to the east than they do now; or that the Hay Head limestone had originally all the Wenlock shale and limestone, and all the Ludlow shale and limestone over it.

After the whole of the Upper Silurian rocks had been deposited over this area, then they were elevated and tilted so as to dip gently towards the west, and a surface was produced upon them by denudation, so that the lowest beds cropped out to that surface on the eastern side of the district, while the highest beds were only found upon the western side.

At whatever time the elevation and denudation commenced, the area apparently remained dry land till late in the Carboniferous period, when it was depressed, by a slow and gradual movement probably, beneath the waters in which the Coal-measures were deposited. That those waters were marine waters, during part of the time, at all events, is shown by the occurrence of brachiopodous bivalve shells in some of the beds; but that they were largely imbued with terrestrial products is rendered equally certain by the abundance of ferns and other land plants, while with respect to some of the conchiferous bivalves (formerly called *unio*, now styled *anthracosia*), no certain decision can be arrived at, as to their marine or freshwater habitat.

2. THE COAL-MEASURES.—Upon the eroded and slightly cliffy and irregular surface of the Upper Silurian rocks were deposited the shales, the sandstones, and the conglomerates of the base of the Coal-measures. Any attempt to correlate

these, which are the lowest beds in South Staffordshire, with the beds which are the lowest elsewhere, is in my opinion quite useless; neither am I disposed to regard any attempt at identification of any of the South Staffordshire beds with those of other coalfields with greater favour.

Even within the limits of the South Staffordshire coalfield itself there is so much change, so much thickening and thinning out in the different measures, that great difficulty and uncertainty is felt in the attempt to identify the beds of the Wyrley district, for instance, with those of Bilston, while no one has ever attempted to guess at the relations of those of Brereton with any others in the district.

In order to give any accurate account of the Coal-measures, we are obliged to divide the coalfield into three parts,—the southern, the middle, and the northern parts. The southern part is all that which lies south of Wolverhampton, Bentley, and Walsall; the middle, the part round Wyrley and Cannock Chase; and the northern, the part nearest Brereton.

The southern part is the richest, being that in which the Thick coal is found, and that which most abounded in ironstone.

I insert here the abstract account of the Coal-measures of these three districts, as given in the "Survey Memoir on the South Staffordshire Coalfield."

GENERAL SECTION of the Central and Southern Part of the Coal Field.

					FT.	FT.
1.		Beds above the Upper Sulphur coal	1*a*. The Hales Owen sandstone group ... 1*b*. The Red Coal-measure clays... ...		600 to	800
2.		Upper Sulphur coal			about	1
3.		Intermediate measures				140
4.		Little or Two-foot coal				2
5.		Intermediate measures		from	2 to	48
6.	(I.)	BROOCH COAL			about	4
7.	(*I.* 1.)	Brooch binds ironstone measures		from	7 to	20
8.		Herring coal (not known north of Dudley) ...			about	1
9.	(*I.* 2.)	Pins and Pennyearth ironstone measures ...		from	7 to	30
10.		Intermediate measures containing the sandstone known as the Thick coal rock		„	38 to	157
11.	(*I.* 3.)	Broad earth, Catch earth, and Batt, containing the Ten-foot, and Backstone ironstones in the Pensnett district		„	6 to	14
12. THICK COAL.	(II.)	Roofs coal or top floor			about	30
	(III.)	Top slipper, or Spires, or Spin coal ..				
		These two form the Flying reed when separated from the coals below.				
	(IV.)	Jays, or White coal...				

				FT.		FT.
12. THICK COAL.	(V.)	Lambs, or Floors, or Fine Floors coal ... These two are often either mentioned together under the name of White coal, or else the lower one is absent		about		30
	(VI.)	Tow (tough) or Heath coal				
	(VII.)	Benches coal (this bed is but rarely mentioned).				
	(VIII.)	Brassils, or Corns coal				
	(IX.)	Foot coal or Bottom Slipper, or Fine coal				
	(X.)	John coal, or Slips or Veins coal				
	(XI.)	Stone, or Long coal...				
	(XII.)	Patchells coal (sometimes absent or not mentioned).				
	(XIII.)	Sawyer, or Springs coal				
	(XIV.)	Slipper coal				
	(XV.)	Bottom Benches, or Omfray (Humphrey), or Red, or Kid (Kick ?), or Holers coal				
13.	*I.* 4.)	Pouncill batt, Blacktery and Whitery, containing the Grains ironstone, and sometimes the Whitery ironstone	from	2	to	8
14.	(*I.* 5.)	Gubbin ironstone measures, sometimes called the Little, or Top, or Thick coal gubbin, sometimes the Black ironstone	„	2	to	8
15.		Table batt or intermediate measures	„	2	to	28
16.	(XVI.)	HEATHEN COAL	„	about		3
17.		Intermediate measures (sometimes wanting)	from	0	to	43
18.	(XVII.)	RUBBLE, or LOWER HEATHEN coal, sometimes, when the measures above are wanting, forming the bottom part of the Heathen coal, sometimes itself wanting, when the measures above and below seem to be both present	„	2	to	4
19.	(*I.* 6.)	Intermediate measures containing, at Bentley, the ironstone known as the Lambstone and Brownstone	„	10	to	33
20.	(*I.* 7.)	New Mine or White ironstone	„	2	to	10
21.	(*I.* 8.)	Measures containing the Penny-stone ironstone, called also Bluestone or Cakes	„	10	to	25
22.	(XIX.)	SULPHUR coal	„	2	to	9
23.		Intermediate measures	„	3	to	99
24.	(XX.)	NEW MINE coal	„	2	to	11
25.	(*I.* 9.)	Measures containing the Fireclay Balls ironstone occasionally	„	2	to	40
26.	(XXI.)	FIRECLAY coal and partings	„	1	to	14
27.		Intermediate measures	„	2	to	10
28.	(*I.* 10.)	Getting Rock ironstone (occasional)	„	4	to	5
29.	(*I.* 11.)	Poor Robin ironstone measures	„	3	to	5
30.		Intermediate measures sometimes wanting	„	0	to	9
31.	(*I.* 12.)	Rough Hills White ironstone (occasionally) ...	„	2	to	19
32.	(XXII.)	BOTTOM coal	„	3	to	12
33.		Intermediate measures	„	5	to	30
34.	(*I.* 13.)	Gubbin and Balls ironstone, sometimes called the Great or Bottom Gubbin	„	3	to	10
35.		Intermediate measures	„	18	to	50
36.	(XXIII.)	SINGING or MEALY GREY coal (occasional)...	„	2	to	4
37.		Intermediate measures	„	16	to	50
38.	(*I.* 14.)	Blue Flats ironstone	„	2	to	9

			FT.		FT.
39.	Intermediate measures	,,	10	to	14
40.	(*I.* 15.) Silver Threads ironstone...	,,	4	to	7
41.	Intermediate measures	,,	6	to	15
42.	(*I.* 16.) Diamonds ironstone	,,	2	to	3
43.	Lowest measures, maximum thickness known below the Diamonds ironstone		about 50		
	Total average thickness		,, 1330		

GENERAL SECTION of the Coal-measures extending from Bentley to Essington and Wyrley on the West, and Pelsall and the Brown Hills on the East.

The capital letters refer to the localities, E standing for Essington, W for Wyrley, B for Bentley, and P for Pelsall.

		Average thickness.	
		FT.	IN.
1.	Various measures; 20 ft. E.	20	0
2.	(I.) Coal, 2 ft. E.	2	0
3.	Intermediate measures; 37 ft. E.	37	0
4.	(II.) Coal, 1 ft. 9 in. E.	1	9
5.	Intermediate measures, 10 ft. E.	10	0
6.	(III.) Coal, 5 small coals with partings, 12 ft. 6 in. E. ...	12	6
7.	Intermediate measures, 3 ft. E....	3	0
8.	(IV.) Coal, 1 ft. E.	1	0
9.	Intermediate measures, 66 ft. E.	66	0
10.	(V.) Coal, 2 ft. E; 1 ft. 9 in. W.	1	10
11.	Intermediate measures, 32ft. E.; 10 ft. W.	21	0
12.	(VI.) Coal, 7 ft. 6 in. E.; (coals and partings 9 ft. 10 in.) W.	8	8
13.	Intermediate, with a small coal, 57 ft. E; 76 ft. W.	67	0
14.	(VII.) Old Robins coal, 5 ft. 6 in. E.; 6 ft. 6 in. W. ...	6	0
15.	Intermediate, 35 ft. E.; 18ft. to 22 ft. W.	25	0
16.	(VIII.) Wyrley Yard Coal, with parting, 5 ft. E.; 3 ft. to 5 ft. 6 in. W.	4	0
17.	Intermediate, including the Yard coal ironstone, 40 ft. E.; 36 ft. to 69 ft. W	47	0
18.	(IX.) Charles coal 2 ft. 3 in. E.; 2 ft. 4 in. to 3 ft. W. ...	2	6
19.	Intermediate, 30 ft. E.; 24 ft. to 26 ft. W.	52	0
20.	(X.) Cannel coal, 3 ft. 8 in. E.; 4 ft. W.	3	11
21.	Intermediate, 60 ft. E.; 54 ft. to 84 ft. W.	71	0
22.	(XI.) Wyrley Brooch coal, 2 ft. E.; 3 ft. 8 in. to 4 ft. W.	3	4
23.	Intermediate, 3 ft. 6 in. E.; 1 ft. to 1 ft. 6 in. W.	1	8
24.	(XII.) Benches coal, 7 in. E.; 2 ft. to 2 ft. 4 in. W. ...	2	0
25.	Intermediate, with a 2 ft. coal, 74 E.; 40 to 48 ft. W. ...	54	0
26.	(XIII.) Wyrley Bottom or Eight-foot, Bentley Old Man's coal; 8 ft. 6 in. with partings E.; 6 ft. to 8 ft. W.; 9 ft. 10 in. B.	8	1
27.	Intermediate, 38 ft. E.; 39 ft. to 46 ft. W.; 45 ft. to 61 ft. B.	46	0
28.	(XIV.) Essington Four-foot, or Bentley Hay coal, 4 ft. E.; 3 ft. W.; 5 ft. sometimes expanded by shale to 11 ft. B.	4	0
29.	Intermediate, 51 ft. to 63 ft. B....	54	0
30.	(XV.) Heathen coal, 1 ft. 8 in. to 3 ft. B.; 21 ft. 6 in.P. ...	2	0
31.	Intermediate, 44 ft. to 56 ft. B,: 61 ft. P.	50	0
32.	(XVI.) Sulphur coal, 1 ft. 6 in. to 4 ft. B.	1	9
33.	Intermediate, 21 ft. to 52 ft. B.; 32 ft. to 52 ft. P.	43	0

		Average thickness. FT.	IN.
34.	(XVII.) Yard coal of Pelsall, 3 ft. to 3 ft. 6 in. B.; 2 ft. 9 in. to 3 ft. 8 in. P.	3	2
35.	Intermediate, 31 ft. to 46 ft, B.; 26 ft. to 50 ft. P.	40	0
36.	(XVIII.) Bass coal of Pelsall, 4 ft. to 6 ft. B.; 3 ft. to 6 ft. P.	5	10
37.	Intermediate. 21 ft. to 35 ft. B.; 29 ft. to 39 ft. P.	31	0
38.	(XIX.) Fireclay or Cinder coal, 3 ft. 10 in. to 6 ft. 8 in. B.; 3 ft. 2 in. to 5 ft. P.	4	6
39.	Intermediate, 21 ft. to 46 ft. B.; 21 ft. to 49 ft. P.	33	0
40.	(XX.) Upper part of Bottom coal, or Shallow coal, 2 ft. to 7 ft. 9 in. B.; 4 ft to 7 ft. P.	5	4
41.	Intermediate, 8 in. to 8 ft. B.; 38 ft. to 51 ft. P. (average of latter)	46	0
42.	(XXI.) Lower part of Bottom, or Deep coal, 2 ft. 9 in. to 4 ft. 8 in. B.: 5 ft. to 15 ft. P.	6	8
43.	Measures between the Bottom coal and the Silurian shale, 137 ft. B.	137	0
		1,053	0

SECTION OF THE BRERETON DISTRICT.

		FT.	IN.
1.	Red sandstone and white gravel (part of the New Red Sandstone conglomerate)	80	0
2.	Red and yellow marl, rock, clod, and batt	16	6
3.	(I.) First coal	4	6
4.	Clod, with ironstone	19	10
5.	(II.) Second coal	2	6
6.	Clod and rock	51	3
7.	(III.) Third coal	2	0
8.	Fireclay and clod	13	0
9.	(IV.) Fourth coal	4	0
10.	Rock clod and ironstone	30	1
11.	(V.) Fifth coal	4	0
12.	Fireclay	3	0
13.	(VI.) Sixth coal	0	4
14.	Rock, with ironstone	14	8
15.	(VII.) Seventh coal	2	3
16.	Rock, with ironstone, clod, and batt	36	0
17.	(VIII.) Eighth coal	4	0
18.	Batt and clod, with light rock	50	0
19.	(IX.) Ninth coal	0	6
20.	Clod, &c.	6	0
21.	(X.) Tenth coal	3	3
22.	Rock	13	4
23.	(XI.) Eleventh coal	1	0
24.	Clod, rock, and ironstone	22	10
25.	(XII.) Twelfth coal	9	0
26.	Rock, binds, and ironstone	48	7
27.	(XIII.) Coal, not enumerated	2	0
28.	Binds, with ironstone	21	7
29.	(XIV.) Thirteenth coal	5	0
30.	Fireclay and clod	24	0
31.	(XV.) Fourteenth coal	1	0
32.	Rock, clod, and ironstone	105	8
33.	(XVI.) Fifteenth coal	4	3
34.	Red measures, thickness not stated		
		605	11

It will at once be seen, from a comparison of the sections of these three parts of the same small Coalfield, how impossible it is to identify the coals of different localities by mere thickness, either of the coals or of the intermediate measures. No one has yet ventured in the Brereton part of the Coalfield to identify one of the coals there got with one of those that are got either in the Brown Hills or the Wyrley districts, nor is it probable that this will be done until some bed is actually traced by working across Cannock Chase up to Brereton.

In the distribution of these several measures and groups of measures it is observable that the beds of coal are the most regular and equable, and extend over the widest areas; next to them in regularity of thickness and extent of area are the fine argillaceous beds, the *batts* and the *binds*, the sandstones and conglomerates being most irregular in thickness and most uncertain in occurrence. This is what we should expect if we reasoned *à priori* from the "power of floatation" of the different materials in water, or their relative rapidity of subsidence to the bottom of any water through which their materials were diffused.

The impregnation of the clays with a sufficient quantity of carbonate of iron *(chalybite)* to make good clay ironstone is likewise a local occurrence. The ironstones which have the widest extension are those numbered *I.* 5 and *I.* 7 in the first list at page 7, viz:—the Gubbin, (called also Little Gubbin, Top Gubbin, or Blackstone), and the Whitestone or New Mine ironstone. The Blue Flats ironstone is confined to the district between Wolverhampton and Walsall, and the Silver Threads and Diamonds below it are still more restricted. North of Wyrley and the Brown Hills the measures cease to be productive of ironstone so far as is at present known.

In tracing the beds from the southern into the middle part of the coalfield (say from Bilston to Bloxwich) the only coal bed which is known by the same name throughout is the Heathen coal, No. 16 of the first list and No. 30 of the second. There can be little doubt of the correctness of the identification, and it therefore serves as an horizon to connect the beds above and below it in the two areas. On comparing the two lists it will be at once apparent that the Thick coal, No. 12 of the first list, must be composed of the coals numbered 12 or 14 to 20 in the second list, the coals having come together in consequence of the dying away of the intermediate measures towards the south. Even when we enter the Thick coal district, coming from the north, it is found that the coalition of the coals is not at first complete, for the Thick coal is at first an *eight-yard* coal only, the White coal being its top measure, and it is not till we get as far south as Bradley that the coal becomes a ten-yard coal, by the gradual junction of the two uppermost measures, the "top slipper" and "roofs."*

The Thick coal having been originally worked further south where it was a full ten-yard coal, the separation of these two upper measures towards the north was denoted by the term of the "flying red" or "flying reed." It occurs also towards the west in the Kingswinford district. One thing is very remarkable about it, and that is, that wherever these beds leave the Thick coal, as the "flying red," the thickness between them and the Brooch coal above them diminishes nearly in the same proportion as the thickness between them and the White coal increases.

This is readily intelligible on the hypothesis of the whole series of beds, coals included, being deposited under water by the equable strewing of materials, so far as those materials could be diffused by the gentle currents of the water before they came to rest upon the bottom.

But if each coal was formed as a perfectly horizontal bed at the level of the water, unequal subsidences always rectifying any previous irregularity of level in the surface of the other beds, and unequal depositions always occurring to require fresh rectification, it seems to me too complicated a process to be a natural one.

IGNEOUS ROCKS.

Believing that all the igneous rocks were formed during the Carboniferous Period, I prefer to mention them here, before passing to the rocks of the Permian and Triassic periods.

There are three varieties of igneous rocks, which I believe to be merely varieties of the same original substance, resulting from the difference of the circumstances attending or following its consolidation.

Some of the igneous rocks occur as intrusive sheets or dykes; these masses are generally distinctly crystalline, of a green colour, and would be called "greenstone" by geologists, as they are called "green rock" by the miners. They decompose into a greenish brown rotten sort of stone.

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* My attention was lately called to this circumstance by Mr. Silas Bowkley, F.G.S., of Batman's Hill.

The coals, clays, shales, and sandstones, in contact with these masses, have clearly been affected by them, being usually harder and more brittle the closer they are to the igneous rock.

Another variety is a black close-grained rock, frequently showing a more or less perfectly columnar structure. This is the Basalt or Rowley Rag shown in the Rowley Hills, Barrow Hill, Powk Hill, and other places. During the formation of the Netherton Tunnel, it was found that the columnar basalt on the summit of the Rowley Hills was a comparatively thin capping, and that it rested on some singular green, glistening, fine-grained, softish rock, unlike any I ever saw elsewhere, but which I could readily believe to be some variety of "ash." The green colour was in places mottled with red. If this substance be really an "ash," it must have been ejected from some volcanic vent into the water in which the aqueous rocks above and below were formed, and the columnar basalt of the Rowley Hills must have been poured out as a superficial lava stream, either in shallow water or as a small volcanic island. We may perhaps take the columnar structure itself as an evidence that the igneous rock which possesses it was not deeply buried either in earth or water at the time of its consolidation.

In some of the beds of coal, and especially in the thick coal, we get another variety of igneous rock, which we may call the "White-rock trap." The miners all agree that this variety proceeds from the "Green-rock," in which I believe that they are perfectly correct.

In December, 1853, I visited the Old Park Colliery, at Pensnett, with Mr. SPRUCE and Mr. BECKETT, and was both astonished and delighted with the wonderful exhibition of ragged patches and branching and reticulating veins of "White-rock trap" which ran in all directions through the Thick coal there, in the most picturesque fashion. One irregular mass of this "White-rock trap," which was about four yards in diameter, gradually darkened towards the centre till it became quite black. The specimen which I took from that black nucleus could not be distinguished from a piece of the ordinary rag of the Barrow Hill, which is quarried not a quarter of a mile off. Mr. SPRUCE assured us that the igneous rock dived below ground from Barrow Hill till it rose up again into the Thick coal at the Old Park, and on penetrating, it was changed into "White-rock."

The coal itself, both here and elsewhere, is altered by contact with this "White-rock," being "blacked," as it is called, that is, made dull and earthy looking, and incapable of supporting flame. It is, however, remarkable that the influence of the coal upon the trap seems to have been at least as great, if not greater, than that of the trap on the coal.

Interval between the Formation of the Coal-Measures and that of the Permian Rocks.—Even along the southern margin of the coalfield between Hagley and Harborne, where both Coal-measures and Permian beds lie with apparent conformity, both dipping at a gentle angle to the south, there is evidence of destruction of the older beds having taken place before the deposition of the newer. In the red sandstones quarried on the top of Quarry Hill, south-west of Hales Owen, rounded pebbles of coal were rather numerous, together with rounded and angular fragments of other Coal-measure rocks. Similar fragments of coal and Coal-measure rocks were also found at the base of the Permian rocks in the Heath pits of West Bromwich.

There is indeed no proof of the existence of the latest Coal-measure beds anywhere in the district; while the thickness of the beds above the Thick coal, and beneath the base of the Permians, is known to be very irregular. This thickness is apparently not less than 1,000 or 1,500 feet in the country south of Hales Owen, while near West Bromwich it has been proved by pit sinkings to vary from 500 to 20 or 30 feet—*Memoirs, p.* 136.

It is not unlikely that for some distance, on the eastern side of West Bromwich, the Coal-measures may have been wholly removed before the deposition of the Permian rocks, and that these beds may rest directly on the Silurian rocks.

It is reasonable to suppose that the partial destruction of the Coal-measures was preceded by movements of elevation and disturbance affecting them. In some places they were probably tilted out of their original horizontality; in others they were probably broken by faults; and the Permian beds were probably deposited on a surface formed by denudation on dislocated beds like the present surface.

There is, however, no evidence to show that any of the existing faults acquired anything like their present magnitude of "throw" at this early period, or that any part of the Pre-Permian surface is now preserved, except in those places where it is buried under the Permian beds.

3.—THE PERMIAN BEDS.—These consist of red and brown sandstones and conglomerates, with layers of blood-red clays or marls. Some of the lower sandstones are of a pale wine red colour, precisely like those of the lower red sandstone beneath the Magnesian limestone of Durham.

One very remarkable bed of pebbles of Carboniferous limestone may be seen running continuously for about two miles past Brand Hall and Barnford Hill, two miles south of Oldbury, and again near the Gough's Arms at Great Barr, and in Baggeridge Woods, between Penn and Himley.

The trappean breccia of the Clent Hills is a still more remarkable member of this formation, as it is found at intervals over an area of not less than five hundred square miles in South Staffordshire, South Shropshire, and Worcestershire (see Paper by Professor Ramsay in Q. J. G. S. L., vol. 11, p. 185). The embedded fragments consist of felstone, greenstone, felstone ash, altered slate, red sandstone, and conglomerates, and are believed by Professor Ramsay to have been mainly derived from the neighbourhood of Church Stretton in Shropshire, and to be evidence of glacial action during the Permian period.

In a lane leading from the Bell Inn, Northfield, to Bangham Pit, a cutting in this breccia may be seen, exposing many angular slabs of unaltered Llandovery sandstone, full of fossils as well as fragments of trap (Geol. S. S. Coalfield, p. 9).

This trappean breccia appears to be the uppermost visible part of the Permian beds wherever it occurs. In the sandstones below it, "cornstones" or fine grained sandstones, highly impregnated with calcareous matter and reticulated with strings of Calspar, often occur. It is a curious fact, that in the paper by Dr. Buckland, in which the original description of the rock called "cornstone" is given in a note, these beds are mentioned as *cornstones lying in the Old Red sandstone*, and there is certainly a good deal of lithological resemblance between the lower Permian beds of the Clent Hills and some of the Old Red sandstone of Shropshire and Herefordshire. (See Dr. Buckland, *On the Quartz Rock of the Lickey Hill.* Trans. Geol. Soc. Lond., 1st series, vol. 5, p. 512). These have up to a late date been burnt for lime, near New Town, three miles south of Hales Owen.

According to our section (sheet 23) the trappean breccia of the Clent Hills is about five hundred feet thick, and the Permian beds below them about the same thickness.

In the neighbourhood of West Bromwich we have no appearance of trappean breccia, but the pit sections and railway cuttings would give a thickness of about 1,000 feet as the least which could be assigned to the Permian beds there. Messrs. Davis, of Bullock's Farm, near Spon Lane, sank through 700 feet of red rocks before coming down to the true Coal-measures. At Lord Dartmouth's West Bromwich Heath pits there were 800 feet of them. These beds dipped towards the east. A considerable easterly dip was also shown in the cuttings of the railway east of these pits, and still further east the late Mr. J. W. Unett bored 664 feet through beds which must apparently be above those pierced in the coal pits farther west.

Interval between the Permian and Triassic Periods.—There is not much to be said about this interval. We are not certain that the Permian beds were spread over the whole district; if they were, they were very largely destroyed, and removed again, before the formation of the New Red sandstone, for along the northern border of Cannock Chase the Triassic beds undoubtedly rest directly on the Coal-measures, without the intervention of any Permians.

It is possible, however, that the Permian beds were more or less partial, that they were deposited against old Coal-measure cliffs and banks, and that certain Coal-measure areas were left uncovered by the Permian beds, on to which the Triassic beds subsequently spread, overlapping the Permians.

There is certainly an entire want of conformity between the Permian and Triassic beds, so that we cannot argue from the presence of any part of the New Red sandstone at any place, either for or against the existence of the whole or any part of the Permian beds below it.

After sinking through the New Red sandstone, we might find 1,000 or 1,500 feet of Permian still lying between us and the Coal-measures, or we might come down into the Coal-measures at once, or it is possible that even the Coal-measures may have been removed and we might find ourselves penetrating Silurian rocks or other beds which lie below the Coal-measures.

It altogether depends on what took place in these intervals between the several geological periods, and to make any approximation to the discovery of that requires the most careful and complete collection of observations of fact, and the most severe and logical deduction of inferences from those observations.

4.—TRIASSIC BEDS.—This series of beds may be subdivided into two groups:—

4b.—The Keuper.

4a.—The Bunter, or Variegated Sandstones.

4*a*.—*The Bunter, or Variegated Sandstones*, consist mainly of a soft brick-red sandstone, which can be seen in many excavations on the north-west side of Birmingham. This is occasionally blotched, or streaked with green or yellow.

In this there occur great accumulations of pebble beds. These lie chiefly in the lower part of the sandstone. They are often sufficiently loose to be readily got as gravel with the pickaxe and spade, and rarely, if ever, are so compacted together as to be got in blocks as a conglomerate. The pebbles consist chiefly, but not entirely, of pale brown quartz rock, and the pebble beds have usually a paler and clearer aspect than the breccias and conglomerates of the Permian beds.

The soft red sandstone is a remarkably homogenous rock, but when closely examined, is sometimes found to abound in little grains of black magnetic iron. It may have a maximum thickness of 500 feet, and a similar thickness may be assigned to the pebble beds below it, though it is probable that the latter are capricious both in thickness and position. Beds of red laminated clay or marl are occasionally interstratified throughout.

4*b*.—*The Keuper*.—These beds occur chiefly in the district north of Wolverhampton, and west of Cannock, and that which lies between Birmingham and Bromsgrove.

They consist of brown and white sandstones (called Waterstones in Cheshire, by Mr. Ormerod), in the lower part, and Red clays (or marls) with rock salt in the upper.

The brown and white sandstones have occasional beds of marl interstratified with them, and also of cornstone (or calcareous sandstone) with beds of fine conglomerate occasionally. The white sandstones sometimes make a tolerable building stone, and are used for that purpose near Rugeley. The whole thickness of the subdivision does not exceed 300 feet.

The red marls are probably 600 feet in thickness at least. They contain salt at Droitwich in Worcestershire, and Shirleywich in Staffordshire; but its occurrence is only known by means of brine springs and wells. They also contain a building stone, a kind of dove-coloured sandstone, in their upper parts.

Liassic or Rhætic Beds.—In two places the red marls are capped by the lower beds of the Lias (now known as the Rhætic beds), namely, near Knowle, south of Birmingham, and on Needwood Forest, near Abbott's Bromley. The occurrence of these outliers is interesting for two reasons, first, as showing that at those localities we have the whole thickness of the New Red sandstone below them, as originally deposited, for it is not known that any unconformability or overlap occurs between the New Red and the Lias. Secondly, as proving the great amount of denudation that has occurred since the Oolitic period. These outliers, and the one in Cheshire, must be parts of a great formation that once spread continuously over the whole country. The coalfield must formerly have been covered by the Permian, the Triassic, and the Oolitic beds at least; nor can we suppose that the denudation which removed them spared the lower rocks when they were again uncovered, so that the Coal-measures must have suffered, both in the intervals antecedent to the deposition of the Permian and the Triassic beds, and again during the long interval which has elapsed from the time of their being uncovered again (the date of which is altogether unknown), down to the present day. During the last two centuries man has been the most active denuding agent, and has introduced a new phase of that action which removes matter, not only from the surface, but extracts it from between the beds that lie below the surface.

Glacial and other Drifts.—Having always had a personal distaste for the investigation of superficial accumulations, which has lately been so fruitful in interesting and important results, I can say but little about them. To me "the Drift" has always been a nuisance, which obscured the rocks and made real geological researches more difficult than they otherwise would have been.

Within the limits of the coalfield there are deep hollows in the Coal-measures, filled up with fine red sand. A band of this sand, about a quarter of a mile wide and 90 or 100 feet deep in some places, runs from Moxley (between Darlaston and Walsall) to Marshend, a little east of Wednesfield. I have often wondered whether this could be an old river valley, filled up with sand.

Patches of red clay also occur about Wolverhampton, containing broken fossils from the Lias and the Oolites, boulders of lead ore, and other matters that must have come from a distance, and some of them apparently from the eastward or south eastward.

Beds of gravel also occur, and when these rest upon the New Red it is sometimes not very easy to tell whether they are of the age of the New Red sandstone or of some subsequent period. When they consist wholly of the materials of the *pebble beds*, the problem is often insoluble, with certainty; when they contain Chalk flints they are of course posterior to the Chalk, at all events; but whether they were deposited during the Pleistocene period or belong to the glacial drift I do not know.

There are, however, in and about the coalfield, abundant traces of the presence of ice, either as a great coating over the land or as bergs when it was beneath the sea, in the occurrence of great blocks of Cumberland, Westmoreland, and other northern rocks lying here and there about the surface.

POSITION AND LIE OF THE ROCKS.

The coalfield is an island of Palæozoic rocks surrounded by the Triassic beds.

The lie of the Palæozoic rocks may be sketched as follows:—An anticlined ridge, complicated by three local irregular dome-shaped elevations, runs from Dudley for four miles to the N.N.W. The three dome-shaped elevations, the most northern of which has an elevated synclinal trough attached to it on the west, bring up to the present surface the Silurian floor on which the Coal-measures rest, and this floor rises again to the surface on the east about Walsall, but at a much more gentle angle than on the anticlinal ridge. Between these two Silurian exposures the Coal-measures lie in a shallow basin tilted up a little to the north, so that the beds below the Thick coal crop to the surface between Wolverhampton and Walsall. They are however soon thrown in again by the great Bentley fault, which is a down-throw to the north of 120 yards, and north of which dislocation they have no longer a basin-shaped form, but dip gently but steadily to the west, so that the higher beds (representing the Thick coal) come in about Wyrley, and the lower beds crop about the Brown Hills. North of that the Coal-measures seem to retain pretty much the same lie up to Brereton.

South of Bilston the beds dip gently to the south, and are also thrown down to the south by a succession of faults which range east and west across the basin till we come as far south as Tipton. On the east they crop gently towards the Walsall Silurian district, but are sharply bent up into a nearly vertical position on the flanks of the dome-shaped Silurian elevations as they crop to the anticlinal on the west.

Round the southern and south-western margin of this anticlinal the Coal-measures lie at a more gentle angle, dipping everywhere towards the south and south-west, in which direction they are also thrown down by a long fault, called "the Russell's Hall Fault," which runs from north-west to south-east, parallel to the direction of the anticlinal ridge, but extending much farther to the south-east.

At right angles to this direction, from the southern termination of the anticlinal ridge, in the town of Dudley, a pair of faults forming the Dudley Port trough run to the north-east for about three miles; and it is remarkable that the faults on the south-east side of that trough run mostly north-east and south-west and are down-throws to the north-west, while to the northward of the Dudley Port trough the faults run chiefly east and west, and are down-throws to the south.

The high ground to the south-east of Dudley, capped by the Rowley basalt, continues in the same line as the high ground of the anticlinal on the north-west of Dudley. The tilting and disturbance of the beds, however, is not apparent south-east of Dudley, except by the continuation of the Russell's Hall fault, since the Coal-measures seem to be nearly horizontal under the Basalt, and in all the district to the south of Oldbury, as far as the Birmingham and Hales Owen road at all events, and as far as is known to the south of that up to the Permian boundary.

The portion of the coalfield which lies between Dudley and Stourbridge is divided into two irregular basins by the Netherton anticlinal, which runs north-east and south-west for about three miles from Netherton to the Lye Waste. The Thick and other coals crop round this local elevation in continuous lines. The outcrops of the Thick coal are about a quarter of a mile apart in the central portion of the ridge.

A mass of Basalt shows itself on the axis of this anticlinal a little south of Netherton, but has obviously had no more effect in disturbing the beds there than in other places. The greatest disturbance has been produced at the Lye Waste,* where some of the Ludlow rock, with its included limestone, shows itself at the present surface, and the Thick coal just east of it was tilted into a vertical or even an inverted position.

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* A good section across this part of the anticlinal, showing the outcrop of the lower coals, was exhibited in the cutting of the Birmingham and Stourbridge railroad just north of this place.

From Netherton and Brierley Hill and the Old Park the Coal-measures dip gently towards the west till they are cut off by the Kingswinford boundary fault. From Dudley Wood and Cradley they appear to dip regularly but gently towards the south till they are covered by the Permian beds which form the high ground of the Clent Hills and Frankley Beeches.

Thus the southern end of the coalfield seems to be covered by the Permian beds, resting in apparent (but only apparent) conformity* on the Coal-measures; while the northern end seems to be covered unconformably by the Triassic beds. On the east and west the coalfield is bounded by long down-throw faults, which bring in the Permian and Triassic beds variously against the Coal-measures. Other faults have been traced in these beds themselves, in the country both east and west of the coalfield.

It is probable that many of these faults may have originated at different periods, and almost certain that in none of them has the whole amount of throw been produced at once. They are the result of slow creeping movements in the rocks at the different periods when the district has been affected by those disturbing influences, of which we see the external symptoms at the present day in the occurrence of earthquakes.

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* The proper definition of unconformability is "The upper group of beds resting on an eroded surface of the lower group."

SOUTH STAFFORDSHIRE COALFIELD.

METHOD OF WORKING—VENTILATION—EXTENT AND DURATION OF COALFIELD.

BY HENRY JOHNSON, F.G.S.

METHOD OF WORKING.

THE modes of working the different seams of Coal in the South Staffordshire Coalfield vary, according to the thickness and nature of the seam. The "thick" or 30-foot seam, and other coals exceeding 8 or 10ft. thick, are almost universally worked by what is called "square work" or "pillar and stall," whilst seams under 8ft. thick are worked by the ordinary "long wall" method. In about half a dozen collieries in the district where the different beds comprising the "thick coal" are widely separated by extra thickness of partings or spoil between them, it is worked in two works called "top" and "bottom" workings, and each working, in this case, is what may be termed a modification of the "pillar and stall and long wall" methods. The working of the thick seam "at twice," as it is locally termed, is only practised, however, where the nature of the seam, the demand for the smaller descriptions of coal, and all other circumstances are favourable. Great advantages have been hinted at in favour of this mode of working the Ten-yard coal as compared with the ordinary pillar and stall mode, the full thickness of the seam; but no account of the advantages of working it at twice, in a commercial point of view, has ever yet been laid before the mining public. Where the Ten-yard coal exists free from an excessive thickness of partings or spoil, the universal practice is to work it by "pillar and stall," leaving pillars and ribs for temporary support during the first working, and which are recovered by a second or even a third working over the same ground, after the roof has fallen, and the superincumbent strata has had sufficient time to become semi-consolidated.

The mode of working by pillar and stall, in the first instance, is by excavating the coal in large chambers or "sides of work," the average size of which would be about 50 yards by 50 yards, supported by 4 pillars, each about 9 yards square, and the whole surrounded by a solid rib of coal of from 6 to 10 yards in width, according to circumstances. The whole thickness of 30 feet is taken out in the stalls and openings between the pillars and between the pillars and surrounding rib, after which the rock roof falls, and, in a great measure, fills up the excavated space. The working proceeds chamber after chamber, until the colliery is worked over, each chamber being kept perfectly distinct, both for the purposes of ventilation and to prevent the spontaneous combustion (called "fire stink") of the refuse slack on the floor taking place, which is often the case, and, but for the isolation in chambers, or "sides of work," as they are more familiarly termed, would extend over the whole pit. The necessarily large accumulation of refuse slack and dirt of this thick seam is exceedingly liable to spontaneous combustion, from decomposition, and is very troublesome, both during the first and second working. Large quantities of sulphuretted hydrogen and carbonic acid gas are evolved, and these two evils very much limit the extent of mine which can be economically raised by virtue of one winning. Ten acres is considered about an average quantity to raise at one pair of pits in South Staffordshire, and 20 acres would be a medium-sized colliery, whilst 50 or 60 acres is set down as a large colliery.

When all the coals in each of the before-mentioned chambers are taken out, they are "dammed up" or hermetically sealed by a secure stopping in the narrow neck or "bolt hole" which leads into each chamber, so as to exclude the air and arrest the decomposition and spread of "gob fire."

The second working is what is termed "rib and pillar working," and consists in driving roads partly through the fallen débris of the previous workings, and getting out as much of the pillars and ribs of coal left in the first working as circumstances will permit. Even third "drivings" after the remnants are sometimes practised, but with far more success in ancient first workings than those of modern date. So much for improved mining.

VENTILATION.

The extent to which the ventilation of the mines of South Staffordshire is carried is not necessarily of so scientific and complicated a character as practised in the extensive collieries of the North of England, or of the thin fiery seams of Lancashire, South Wales, or the Midland Counties.

With the exception of what gas may be met with in working maiden mine (of which there is now but very little to boast of), or in cutting through previously unexplored faults, very little trouble is experienced from the presence of fire damp, or carburetted hydrogen. When gas accumulates in the chambers, "or sides of work," previously described, it is harmlessly and effectively carried off by elevating, or "sumping up" the mouth of the *intake* air current to the highest point at which the coals may be hanging in such chamber. Such height of course increases as the coals are hewn down and taken away.

Probably, not even in the North of England is the principle of splitting the air practised with more beneficial effect than in ventilating the Thick coal of South Staffordshire. Each chamber, or "side of work," has its separate split of air, and wherever this has been carried out in its integrity, and an explosion has unfortunately occurred, its effect has rarely extended beyond the particular chamber in which it took place; the workmen in the other chambers having escaped uninjured.

According to the return of the Government Inspector for this district for the year 1864, out of 540 collieries at work, only twelve persons were killed from explosions of gas, and, at most, only two persons by one explosion, whilst probably fifty or sixty persons were in the pit at the time uninjured.

By the same report it is estimated that 10,206,000 tons of coal, of all sorts, were raised during the year 1864, and the deaths *from explosions of gas* being twelve, or one death to every 850,500 tons raised, shew the small risk from explosions in this coalfield as compared with others.

This good effect may be attributed to the complete isolation of the working places of the different bands of workmen, and shews how advantageously this principle of isolation of working places may be carried out in fiery thin seams.

The small amount of carburetted hydrogen given off does not necessitate the introduction of a large quantity of air; besides which a large influx of cold air has the effect of rapidly decomposing the accumulated refuse of the mine, and thus hastens spontaneous combustion; so that in this district ventilation is restricted in the thick seam to what is absolutely necessary, and no more. No excess is permitted if it can be prevented.

The gases which are most troublesome in this district are sulphuretted hydrogen and carbonic acid gas, arising from the slow, but sure, combustion of the unsaleable refuse of the Thick coal, both in the whole coal and broken workings, more especially in the latter—a south-westerly wind invariably favouring the emission.

"Gob fire" is comparatively unknown in all the other thin seams of the district, but they possess their full share of carbonic acid gas.

Ventilation, on account of the very limited extent of the collieries here, is, generally speaking, carried on by very simple means. No very powerful arrangements are needed, for the reasons stated above, besides which the artificial heat produced by the smouldering "gob fire" is sufficient to produce a difference of ten degrees of temperature between upcast and downcast, and thus produce sufficient artificial ventilation. In the deep and more extensive collieries furnace ventilation is, however, resorted to.

The origin of "gob fire," or spontaneous combustion of the refuse of the mine, has for some time occupied the attention of both practical and scientific men of not only this district, but of other districts where "gob fire" is experienced. Some assert that its origin is to be found in the decomposition of minute iron pyrites in the coal, and in the carbonaceous partings between the beds of coal; whilst others as stoutly assert that it is due solely to the decomposition or oxidation of the finely-divided pure coal slack, or dust. Whichever of these theories may be the true one, it is an admitted fact amongst all the practical colliery managers of the district that an undue amount of ventilation facilitates decomposition and ultimate combustion.

As this difficulty is more peculiar to South Staffordshire, and is, more or less, constantly in the mine from the commencement to the finish, and necessitates a great waste of coal to "rib it off," the subject deserves the best attention of mining chemists generally.

EXTENSION AND PROBABLE DURATION OF THE COALFIELD.

Both the extension and duration of this coalfield are questions open to a very great difference of opinion. If the extent was limited to the portion of the district at present explored the duration might be tolerably accurately calculated, as all the coals that can be possibly reckoned upon in a descending order in this coalfield have long since been discovered.

It is to the confines of the present coalfield, then, that any hopes for fresh supplies can be looked for; and it is a very interesting fact that on all sides of the coalfield explorations are being most successfully carried on, with, perhaps, the exception of the eastern boundary, or Birmingham side. But the great depth at which the Thick coal has been last worked in the neighbourhood of West Bromwich (about 400 yards in depth) has probably retarded exploring operations in that direction.

The result of operations now going on in other portions of the coalfield is, however, being looked forward to with great interest, as affording sufficient evidence to warrant an attempt to reach the coal through the Permians at Smethwick and Harborne.

During the last ten years, more especially the last five, a great number of new winnings have been made on the north end, or Cannock Chase district, as also on the north-east, at Aldridge, and at Himley, and other places; but probably the most important recent trial sinkings are those on the south end of the coalfield in the neighbourhood of Hales Owen, Corngreaves, Cradley Park, and Wassel Grove. In the event of the one at Hales Owen, belonging to Mr. J. S. Dawes, and that of Wassel Grove, belonging to Messrs. Geo. Pell and Co., discovering the Thick coal—both of which look very promising, and are now sunk to about half-way to the coal—more than 4,000 acres of the thick seam may be considered proved; and this assurance will, no doubt, give a fresh impetus to additional search even further south than those now in operation.

Very rapid strides are now being made in developing the thin seams over several thousand acres of previously unexplored ground on Cannock Chase, which is now being intersected by canals and railways in every direction, and having direct communication with the more immediately coal-consuming district of the "Black Country." These thin seams, however, are speedily exhausted as compared with the Thick coal seam.

A scheme for proving the continuity of the coalfield underneath the Permian on the downthrow side of the Great Western boundary fault at Essington, on the property of

Mr. H. C. Vernon, is now in course of formation. It is proposed to form a fund for this purpose, by subscriptions from all the adjoining land-owners likely to be benefited by such a proof, upon the same principle as Mr. Dawes's scheme at Hales Owen. In this case it is proposed to drive from the existing coal workings on the upthrow side of the great fault which lie at a depth of about 200 yards from the surface, across the fault into the Permian district, some 200 or 300 yards horizontally, and then bore up or down, in the hope of discovering the position of the Coal-measures underneath.

There is, however, a much more comprehensive scheme for extending the coalfield and exploring the whole Permian districts lying between the South Staffordshire Coalfield and the Warwickshire and Shropshire Coalfield, particulars of which may be found in the Transactions of the Dudley and Midland Geological Society for June, 1865, p. 73.

To attempt to estimate the probable duration of the coalfield, whilst these somewhat important recent additions are being added to it, would be impossible; but it may be observed that such additions are not keeping pace with the enormous consumption and consequent rapid destruction of the parent portion of the coalfield.

In a very valuable paper read by Mr. Wm. Mathews, in August, 1860, before the Institute of Mechanical Engineers at Birmingham, after obtaining the best evidence on the subject, he estimated the then duration of all parts of the coalfield at an average of about forty years from that period.

There can be no doubt but that in one-half those number of years a very large portion of the earlier developed part of the coalfield will be totally and for ever exhausted. As for instance, the mines in the neighbourhood of Bilston, Coseley, Tipton, Wednesbury, Oldbury, West Bromwich, Buckmore and Brierley Hill are being fast worked out, and in twenty years hence will be well-nigh totally exhausted.

THE ECONOMIC VALUE OF VARIOUS MEASURES OF COAL AND IRONSTONE IN THE SOUTH STAFFORDSHIRE COALFIELD.

BY SAMUEL BAILEY, F.G.S.

THE minerals produced in this district are, doubtless, among the most valuable of the United Kingdom :—

The Ironstone measures, together with the seams of coal, form a mixture from which iron can be made of an unsurpassable quality, and have placed this foremost among the iron-making districts of the country.

To give some idea of the vast productions of a particular locality of this coalfield, it may be mentioned that the coal and ironstone gotten there realised a commercial value of £20,000 per acre. This was, however, in the days of South Staffordshire's greatest prosperity — before so many other districts had successfully manufactured iron at a less cost, though not of a superior quality, to that of South Staffordshire.

It is to be regretted that the mines, which together produced this almost incredible result, are now nearly exhausted.

In referring to the various measures of coal and ironstone, it will be better understood by separating the coalfield into five divisions, to shew where the various measures hereinafter spoken of are located, as they do not uniformly exist over the whole coalfield; and in some cases where they are the same seams, they vary much in position, and differ in quality, in some instances being better, and in others inferior.

The measures particularised in this paper are those only which are generally worked, and for the following purposes, viz. :—

1st. For domestic purposes.
2nd. For making gas.
3rd. For manufacturing purposes.

Division No. 1.

The northern boundary of this southern division is formed by a line, drawn from West Bromwich (on the eastern side of the coalfield) through Tipton and Deepfields, to the western fault, near Sedgley.

The Coal and Ironstone measures existing under this division, are as follows, viz. :—

1st. Brooch Coal.
2nd. Thick, or Ten-yard Coal.
3rd. Gubbin Ironstone.
4th. Heathen Coal.
5th. White Ironstone.
6th. New Mine Coal.

The economic uses of these different seams of coal, which are all bituminous are various. Anthracite is not found here, nor does the district contain Cannel coal of any value.

1*st. Brooch Coal.*—This seam of coal is of very superior quality, exceedingly hot and swift burning. It is used exclusively for domestic purposes, and has always realised a high price—at one time, as much as 15s. per ton at the colliery. It must, however, be borne in mind that a ton of coal in this district is not 20 cwt., but mostly 25 or 27 cwt., as gauged in boats, which is the most frequent mode of carriage. This will account for the high price obtained for coal in this coalfield. The seams are generally estimated to produce 1,000 tons per acre, per foot in thickness; whereas, in other districts, the average produce is 1,200 tons, at the least, because sold by machine weight. It is to be regretted that one uniform weight of 20 cwt. per ton is not adopted throughout the kingdom. It is a favourite coal in Birmingham, and the counties of Worcester, Gloucester, and Hereford; but the supply now is very limited, and the coal known as the "Cannock Chase Deep," hereafter referred to, and which so much resembles it, is supplying its place.

2*nd. Thick or Ten-yard Coal.*—This magnificent seam of coal, which has been worked to a very considerable extent from an early date, is composed of ten or more beds, to which different names are applied, and which are as follows, viz :—

1st. Roofs Coal.
2nd. Top Slipper.
3rd. White Coal.
4th. Lambs and Low Coal.
5th. Brazils.
6th. Foot Coal.
7th. John Coal.
8th. Stone Coal.
9th. Slipper and Sawyer.
10th. Benches.

Nos. 1, 2, 3, 4, and 9 beds are the most pure, and of excellent quality, and adapted for the most delicate manufactures of the Midland Counties, from the annealing of a needle to the welding of a gun-barrel. This coal is used raw (or uncoked) for smelting in the blast furnaces, and other particular uses in ironworks, as well as for domestic purposes.

To this coal much of the credit is due for the superior quality of iron produced in South Staffordshire.

The other beds, Nos. 5, 6, 7, and 8, are not so pure and good in quality, and are used for less important purposes in connection with ironworks.

No. 5 *(Brazils)* is in much request for use in reverberatory furnaces, for which it is well adapted.

No. 10 (the lowest bed), though good in quality, is always destroyed by being cut away by the miners, to get through the overlying beds.

This seam of coal has always realised a high price, being preferred to any other for iron manufacture.

It was certainly the first coal worked in this district, at the surface outcrop, for domestic use; and, from a very interesting book, by Dud Dudley, it appears it was first used by him in the place of charcoal, for smelting iron ore, in 1620.

4th. Heathen Coal.—This seam of coal is of very fine quality, and the best for making gas, and is used raw, for smelting purposes, and is also the best coking coal of the coalfield, the cokes being used for malting and other particular purposes.

6th. New Mine Coal.—This seam of coal, where found workable in this division, is much inferior in quality to those above described, but is much used in mills and forges, for the purposes of which it is well adapted.

It is anticipated, from information obtained from important sinkings now being made to the south of this division, that these valuable measures, which have been worked here with such success, will be found to exist under a considerable area.

Should this be the case, at the present consumption these seams will last another fifty years, at least.

DIVISION No. 2.

The southern boundary is formed by the line describing the northern boundary of No. 1 division, and the northern boundary by a line from West Bromwich Old Church, through Wednesbury, Darlaston, to the north of Bilston, into the western fault, a little to the south of Wolverhampton.

The measures existing under this division are as follows, viz. :—

1st. Thick Coal.
2nd. Gubbin Ironstone.
3rd. Heathen Coal.
4th. New Mine Ironstone.
5th. New Mine and Fire Clay Coal.
6th. Fire Clay Balls Ironstone.
7th. Fire Clay Coal Holders.
8th. Poor Robins and White Ironstone.
9th. Bottom Coal.
10th. Gubbin or Balls Ironstone.
11th. Blue Flats Ironstone.

The first-mentioned seam of coal in No. 1 division (Brooch coal) does not exist in this division, or in any other part of the coalfield hereinafter referred to.

The remarks made with reference to the Thick coal and Heathen coal in No. 1 division will suffice for the same measure in this division; but over the greater part of the area in this division the New Mine coal is in connection with another seam, called the Fire-clay coal, the latter being below it, but only separated from it by a thin band of bat.

These two seams together form a very important measure, from three to four yards in thickness, and, being of a purer and more superior quality to the New Mine coal of No. 1 division, are used raw for smelting purposes, and are much preferred for other special uses in ironworks, and realise a high price.

9th. Bottom Coal.—This seam is not equal in quality to the New Mine and Fire-clay coal, and is generally used for less important purposes; in some instances, for mill and forge purposes, for calcining ironstone, for burning lime, bricks, &c.

DIVISION No. 3.

The southern boundary is formed by the line of the northern boundary of No. 2 division, and the northern boundary by a line drawn from Rushall to Bloxwich, into the western fault, at Wednesfield Heath.

The measures of coal and ironstone under this division, are as follows, viz. :—

1st. Heathen Coal.
2nd. Brown Ironstone.
3rd. New Mine ditto.
4th. Yard Coal.
5th. Four-feet Coal.
6th. Poor Robin's Ironstone.
7th. Bottom Coal.
8th. Gubbin Ironstone.
9th. Blueflats ditto.
10th. Silverthreads ditto.
11th. Diamonds.

1st. Heathen Coal. — This seam is the first below the surface of this division, and is similar in quality to the same seam in Nos. 1 and 2 divisions, but is not of the same thickness; and being near the surface is tender, and more expensive to work. It is used for the same purposes as the same seam referred to in No. 1 division.

4th. Yard Coal.—This seam corresponds with the New Mine coal of the two former divisions. It is, however, much superior in quality, and realises a higher price for domestic purposes, making gas, and raw in the furnaces for smelting.

5th. Four-feet Coal.—This seam exists here, some distance below the Yard coal, and corresponds with the Fire-clay coal of No. 2 division, being similar in quality, and is used chiefly for mills and forges.

7th. Bottom Coal.—This is a very important seam, corresponding with the Bottom coal, and Bottom coal holders of No. 2 division, which are there separated by a considerable thickness of strata, the latter being seldom worked, but are here, in one seam, eleven feet in thickness.

It is specially adapted for mill and forge purposes, and being the cheapest coal gotten in South Staffordshire is much used at the present time in many of the ironworks.

The mines in this division vary more in commercial value than in any other part of the coalfield, being much injured by the "trap rock," or "basalt."

Division No. 4.

The southern boundary is the line forming the northern boundary of No. 3 division, and the northern boundary by a line from Goscote or Rushall, into the western fault, near Cannock.

The measures lying in this division are known as the Essington and Wyrley mines, and those at present being worked are as follows, viz. :—

1st. Black Gubbin Ironstone.
2nd. Brown Ironstone.
3rd. Cannel Coal
4th. Bench Coal.
5th. Bottom Coal.
6th. Four-feet Coal.

This portion of the coalfield is of considerable extent and importance, containing many valuable measures of coal and ironstone, which have not yet been extensively worked, and which are now being looked forward to for the supply of the ironworks in place of that portion of the coalfield so nearly exhausted. It is remarkable that the coal seams are similar in number and (together) in thickness (though considerably separated by strata), and in some instances in quality, to the Thick, or Ten-yard coal; and the seams of coal and ironstone existing in No. 3 division, doubtless exist below them; it is, therefore, impossible, at present, to estimate the commercial value of this part of the coalfield.

3rd. Cannel Coal.—This is a very superior coal for domestic purposes, in good demand, and realises a high price.

4th. Brooch Coal.—This seam is similar in quality to the last one.

5th.—Bottom, or Eight-feet Coal.—This is a very strong superior coal, and very suitable for domestic and smelting purposes, and for the latter it is extensively used.

6th. Four-feet Coal.—This is a valuable seam of coal, and resembles in quality and is the thickness of the "slipper and sawspa" of the "thick, or ten-yard coal," and is suitable either for domestic or smelting purposes.

DIVISION NO. 5,

Will be the part lying north of No. 4 division, extending to Rugeley, being the northern limit of the South Staffordshire Coalfield, and is generally known as the Cannock Chase District. Several valuable measures of coal and ironstone exist here, and the following are being extensively worked, viz. :—

1st. Yard Coal.
2nd. Shallow Coal.
3rd. Deep Coal.

1st. Yard Coal.—This seam corresponds with the yard coal of No. 3 division, and is equal to it in quality, and used for domestic purposes.

2nd. Shallow Coal.—This seam corresponds with the upper portion of the bottom coal of No. 3 division, but is of better quality. It is used for domestic purposes, mills, and forges, and also for steam purposes.

3rd. Deep Coal.— This seam exists about twenty yards below the shallow coal, and corresponds with the lower part of the bottom coal of No. 3 division, but the quality is much superior to it; indeed it is now considered one of the most important seams raised in this coalfield. It is very similar in character and quality to the brooch coal of No. 1 division, as before stated, and is in great demand in the local and distant markets, and realises a very high price.

The area of the two last-named divisions is equal to about 40 square miles, and, at an average estimate, contains 300,000,000 tons of coal, besides ironstone, and, at the average annual produce of 2,500,000 tons (which is equal to one-fourth of the present output of the South Staffordshire Coalfield, according to recent returns), will last a period of one hundred years.

IRONSTONE MEASURES.

The ironstones of this coalfield are argillaceous. They vary in quality, some containing a larger per centage of iron than others; but, when smelted together in the furnaces in proper proportions, form mixtures which work so mildly that they will produce iron of the finest quality.

The per centage of iron contained in them varies from 30, but is mostly from 40 to 50 per cent.

The average yield of any of these measures is not large, but of about an average of 1,300 tons per acre per each seam. It is, therefore, costly in production compared with other districts where the yield is much greater. The analysis of these various ironstones will be found in Dr. Percy's Metallurgy.

LIMESTONE (SILURIAN).

Two measures are worked in various parts of this coalfield, the first being called the thin bed, which is from four to five yards in thickness.

It is principally used as a flux in the blast furnaces, and also is made into lime, for hydraulic and other purposes. The other or thick bed is eleven yards in thickness, and is made into lime, and extensively used for building and agricultural purposes.

Further and detailed information of the coal and ironstone measures in this district will be found in that part of the valuable Memoirs of the Geological Survey relating to the South Staffordshire Coalfield, by Professor Jukes.

THE DRAINAGE OF THE SOUTH STAFFORDSHIRE COALFIELD.

THE South Staffordshire Coalfield, situated on some of the highest table-land in England, contains a drainage-area of about 125 square miles. The ridge of hills stretching from Rowley through Dudley to Sedgley and Wolverhampton forms the natural watershed of the district, and before the surface was disturbed by mines, canals, railways, &c., the area on the South, containing Halesowen, Cradley, The Lye, Brierley Hill, Netherton, and Gornal, was drained by the Stour and its tributaries; the area on the north, containing Oldbury, Tipton, Bilston, Darlaston, Willenhall, Wednesfield, Walsall, and Wednesbury, by the Tame and its tributaries; while the area on the extreme north of the coalfield, containing Church-Bridge, Norton, Cannock Chase, Hednesford, and Brereton, was drained by the Saredon, Bentley, Stow, Crane, and Bilston brooks.

It is difficult to say to what extent these areas have been altered by artificial causes, but the canals alone have absorbed the flow from twenty-five square miles; railway embankments must also have caused considerable modification, and the immense amount of water pumped from the mines must have greatly interfered with the natural drainage. Still, in spite of all the many different channels into which the natural drainage has been diverted, there is no reason to believe that the average amount of water carried off the district has been materially affected. With the exception of the water supplied from a distance by the various Water Companies, the only source of the supply of water is the rainfall, and although a large portion of the amount that penetrates the surface falls to a lower level than formerly, and is now lifted to the surface by artificial means, it only makes a somewhat longer circuit without any increase of quantity. The rainfall in South Staffordshire is less than in many places nearer the coast, and has not averaged for eighteen months more than twenty-two inches per annum. At this rate the whole quantity falling on the 125 square miles of the coal-field would not exceed 108 millions of gallons per day of twenty-four hours. This, therefore, with the addition of four million gallons for water delivered by the Water Companies, in all 112 million gallons, is a tolerably accurate estimate of the total daily water-supply of the district.

The streams flowing off the district are estimated to discharge on an average about fifty-two million gallons per diem, and the amount carried off by the various canals probably amounts to about another ten million. The entire quantity of water therefore flowing from the coal-field is about sixty-two million gallons per diem, leaving only fifty million gallons for evaporation and percolation. The amount of percolation, however, as tested by the amount pumped from the various mines, is ascertained to be fifty million gallons per diem, of which thirty-seven million find their way into the canals, and the other thirteen millions into the natural water channels. It is perfectly clear, therefore, that the amount of water in the mines cannot be due merely to the rainfall, and the only way of accounting for it is to adopt the conclusion that an immense amount after having been pumped out, finds its way back into the mines to be repumped. As the amount flowing off the district together with the amount pumped from the mines is about equal to the total amount of the rainfall, leaving nothing whatever for evaporation, it follows that the amount which finds its way back into the mines is about equivalent to the amount of evaporation over 125 square miles.

The great bulk of the water pumped, as well as a portion of the surface drainage, is received by the canals. With regard to the disposal of this water, it would be impossible to obtain trustworthy information without returns of the lockage from all the various outlets where the water is passed off without being pumped back to the opposite side of the lock. Allowance would also have to be made for evaporation from so large a water-surface, for the quantity used for most of the engines in the district for which the canal forms the source of supply, and for the amount abstracted by various works along the banks. It is, therefore, almost impossible to estimate correctly the real amount carried off by the canals; but if it be taken for granted that all the water which finds its way into them either remains there or is carried out of the district, it materially increases the difficulty of accounting for the amount of water found in the mines.

The foregoing figures are somewhat conjectural, but in connection with certain more clearly ascertained facts in reference to the coalfield, they throw considerable light on a great evil with which coalmasters have to contend,—the return into the mines of water that has once been pumped out of them. The whole of the coalfield is more or less thickly perforated by shafts or dislocated by mining operations. The surface is in many places divided into catchwater pits by the deposit of spoil-banks, in which the water must accumulate to a considerable depth before it can run off,—as although the "crowning in" of old workings often causes a depression of the ground above the pits, the water-courses have to be maintained at their old level,—and perhaps even more frequently, extensive "swags" are to be found from which the water has no means of escape except by percolation through the bottom. In fact it may be said that every mining operation in the district has contributed more or less to the construction of a drainage system for the flooding of the mines.

Formerly the mines were so rich in mineral, and the slack made in getting the coal was so plentiful before the demand arose for its employment in working engines in works unconnected with the mines, that pumping the water from the pits was felt rather as an annoyance than a heavy additional expense. Year by year, however, as the quantity of water to be raised increased, more and more engines have to be employed, and the cost of fuel is continually increasing. With the assistance of the various proprietors, particulars have been obtained of nearly all the engines in the district, and the following calculations, based on ascertained data, will give an idea of the present magnitude of this item in the cost of production.

The amount of water raised by pumps or barrels in the district daily is, as already stated, about fifty million gallons. The weight of this enormous quantity of water is no less than 220,000 tons, or nearly ten times the weight of the coal raised in the same time. About 5,000 horse-power is required to lift it from the various depths, representing plant and machinery to the value of about half a million. The annual expenditure, including interest on capital, incurred in lifting this mass of water is £125,000, or about 3¾*d.* per ton of coal produced in the district. In many cases, of course, this amount represents merely a fraction of the real cost of pumping, and almost every colliery has its own tale to tell of difficulties surmounted or found to be insurmountable with regard to raising the water, of labour fruitlessly wasted, or of expense unnecessarily incurred. Very often the quantity of water to be raised was merely a matter of vague estimate, or a large "pound" had to be pumped before the regular "come" was ascertained, so that, while in some instances insufficient engines were first erected, it more frequently happened that larger ones were employed than were ultimately found necessary. Some of the most serious difficulties, again, have been met with in pumping from mines that have been worked before and allowed to be "drowned,"—the "poundroom" in such cases having so greatly increased as frequently to render the task of emptying the pit almost hopeless. Sometimes, too, the operations have been brought to a standstill by the extremely corrosive nature of the water that has long remained in old workings, which has eaten into the iron of the pumps and rods, and rendered necessary the use of brass working-barrels at a greatly increased cost. These and many other difficulties have enhanced the cost of pumping in a large proportion of cases; but the principal difficulty after all has always been the absence of combined effort on the part of the various proprietors, and the want of some ready means of adjusting the charge in proportion to the benefit received. Difficulties must always be experienced in raising water from the mines, but combined action might at least prevent the water once pumped from finding its way back into the pits, and could not fail to confer an appreciable benefit on the public and the coalmasters themselves. It is true that combined action on a limited scale has frequently been attempted, but in not a few such cases the burden has fallen not on those who received the greatest benefit, but on those who but for some combined action of the kind, would have been wholly unable to bring their mineral wealth to bear at all. One of the most important questions arising out of the present arrangements is with regard to surface watercourses over the property of the others, since without such watercourses, it is often impossible that a mine can be worked. Fortunately, in this particular, the Canal Companies with their Parliamentary powers and direct interest in keeping their canals watertight, have afforded most opportune assistance. The brooks and streams were in many instances destroyed by mining operations as natural outlets for the water pumped from the mines, and but for the canals, many mines would have been totally destitute of any available means of getting rid of the water from their engines, unless their proprietors could have constructed and maintained artificial channels for the purpose. The canals, however, do not by any means supersede the necessity of united action. Could the mines in the South Staffordshire coalfield have been worked from the first on one complete system of drainage, there can be no doubt that an immense amount of capital and annual expenditure might have been saved, and the cost of pumping reduced to something like 1*d.* instead of 3¾*d.* per ton of coal.

In the present coal district it may perhaps be already too late to remedy the evils here pointed out, and any sweeping change in the existing drainage system would possibly be attended with an expense which it is now not worth while to incur. It must not be forgotten, however, that the exhaustion of the coalpits now in operation will at no distant day have proceeded to such an extent as to render mining a profitable speculation in new districts which have hitherto offered no sufficient temptation to commercial enterprise. Whenever the time shall have come for conducting operations in a new area, it is to be hoped that if individual proprietors are found unwilling to unite for the purpose, the Legislature will consult the public interest by insisting on the adoption of a general and comprehensive system of drainage, and thus avert the evils from which the South Staffordshire coalfield has so severely suffered.

STATISTICS OF THE MARKETABLE PRODUCTS OF THE COALFIELD.

Coal.—In his last Report, Mr. J. P. Baker, Inspector of Mines for the district, gives the total number of collieries in South Staffordshire as 540. He estimates the amount of coal raised at 10,306,000 tons, but explains that this amount includes the coal consumed on the collieries, the colliers' allowance coals, &c., and also the residue of the screened coal which is burnt as waste on the pit mounds, and which is put down at 1,344,800 tons, leaving for marketable coal raised from the mine, 8,861,200 tons. Mr. R. Hunt, in the last volume of *Mineral Statistics*, makes the number of collieries 523, and the total amount of coal 8,263,351 tons. No doubt the calculations of both these authorities have been made with great care and detail; but there are so many contingencies to be taken into account that it is impossible to arrive at any exact statistical account of the coal annually produced. This arises mainly from the fact that there is in South Staffordshire no regular statute weight adopted. A boat load is reckoned at 20 tons, but owing to differences in structure, boats are made to hold quantities varying from 20 to 30 tons each. The above estimates are reduced to statute tons; but it is next to impossible to get at the average boat burden of the district for a year. Without attempting to determine which of the above estimates is the most accurate, we can best take Mr. Hunt's as the basis of our calculation with respect to the coal consumed under miscellaneous heads, including the coal used in all manufactures except iron—in colliery work, for domestic purposes, &c. These items represent a total of 3,602,406 tons per annum. The amount used in the manufacture of iron is easily estimated. Deducting the quantity of coke imported from South Wales and the North of England, 2½ tons of coal, short weight, will be required for each ton of pig iron produced. At the present rate of manufacture the annual produce of iron is estimated at 740,000 tons, which would require 1,850,000 tons of coal. The quantity of coal used in producing the 855,000 tons of finished iron turned out in this district annually, will require 2,671,875 tons of coal, allowing 2½ tons of coal long weight, equal to 3⅛ tons avoirdupoise, to each ton of finished iron. The total produce per annum will then be :—

	Tons.
Miscellaneous	3,602,406
Pig Iron	1,850,000
Finished Iron	2,671,875
Total ...	8,134,271

Ironstone.—The iron ores of this district are not so abundant as formerly, as the beds are worked out over considerable areas. The quantity raised during the past year is estimated by Mr. Hunt at 948,000 tons. The produce at the present time, owing to the greater activity of the pig iron manufacture, is probably at the rate of above a million tons per annum. The quantity raised last year would certainly be considerably below the average.

Ragstone for Paving and other Purposes.—The quantity of Rowley and other Basaltic stone quarried for paving purposes, is about 70 to 80,000 tons per annum.

Fire Clay.—This mineral is chiefly raised in the neighbourhood of Stourbridge, Brierley Hill, and the Lye. It is estimated that 100,000 tons are raised per annum.

Limestone.—This scarcely belongs to the marketable products of the coalfield, as the greater portion of it is obtained from the Silurian rocks along the confines of the district. About 250,000 tons are raised for lime burning and smelting purposes; but considerable quantities are also imported.

THE LIMESTONES OF SOUTH STAFFORDSHIRE.

BY EDWARD MYERS, F.G.S.

THERE are in this district three distinct groups of Limestone Rocks, each having several members or distinct beds of stone, separated by shaly, shaly nodular, and flaggy partings of various thicknesses, all belonging to the Upper Silurian formation.

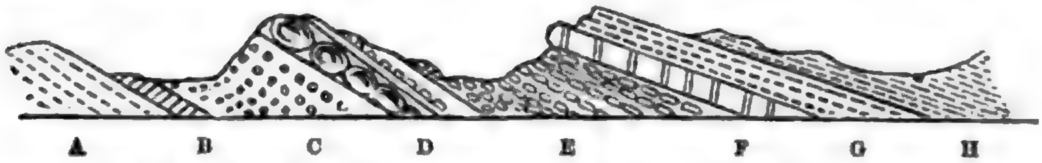
The Upper Silurian series of Rocks comprise the following, and occur in the stratigraphical order in which they are placed below.

At the base of the Devonian or Old Red Sandstone, the

Upper Ludlow	shale, &c.	Upper Silurian.
Aymestry Limestone		
Lower Ludlow Shale		
Wenlock Limestone	shale, &c.	
Woolhope Limestone		

At the base of these occur the Caradoc sandstone, the uppermost member of the Lower Silurian Rocks.

It may considerably assist those of our readers who are not familiar with geological science, to better understand the few remarks we propose to make on the occurrence of these rocks in our own district, by inserting the following diagram,* which represents the natural order in which they occur in the geological series, and in the typical districts of Shropshire and Herefordshire.



A	Caradoc Sandstone.	E	Lower Ludlow.
B	Woolhope Limestone.	F	Aymestry Limestone.
C	Wenlock Shale.	G	Upper Ludlow.
D	Wenlock Limestone.	H	Devonian.

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* The diagram is copied from a section in the Silurian system of Sir Roderick Murchison—p. 196.

Of these Upper Silurian Rocks we have in our district :—

1st. A portion of the Ludlow division, locally called the *Sedgley Stone*, and believed to be the equivalent of the Aymestry Limestone.

2nd. The whole of the Wenlock Rocks, locally known as the *Dudley* and *Walsall Stone*.

3rd. The Woolhope, represented in our locality by the *Barr* or *Hay Head Limestone*.

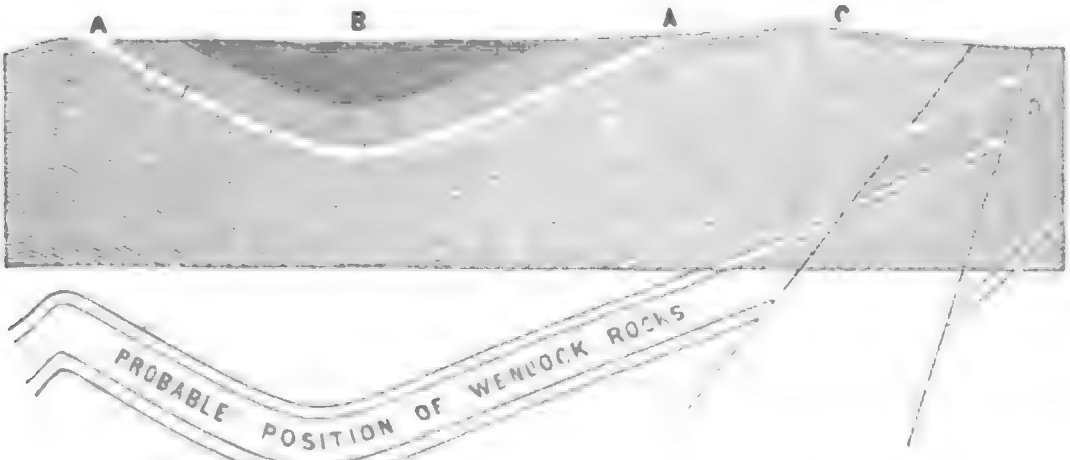
In our district the Devonian of the geological series is absent, and the Coal-measures are found to rest immediately on our Silurian Rocks.

For the most part these rocks do not appear in our field in such a traceable regular order of superposition as clearly to prove their stratigraphical relations. They occur as detached masses, in the form of insulated domes, basins, and terminal out-crops, abruptly driven up through the superincumbent Coal-measures. Thus, from any mere observation of these detached limestone masses, it would be quite impossible to determine their relations and place in the geological series. We are indebted, in the first place, to Sir Roderick Murchison for unravelling these difficult rocks, the determination of their relation to each other, and for the knowledge that they are, in our district, the equivalents of certain members of the Upper Silurian series, as typically developed in Shropshire and some of the adjacent Welsh counties, where the order of superposition is distinctly traceable. And these deductions of Sir Roderick Murchison, formed many years ago, on lithological and fossil evidences, have since been fully verified by the Government Geological Survey of our district undertaken in 1851.

It does not come within the object of this short paper to give anything like a detailed description of the occurrence, fossils, &c., of these rocks of our district. They have been already so fully described in the "Silurian System," and in the second edition of the Geological Survey of the South Staffordshire Coalfield, by Mr. J. Beete Jukes, that to these works we must refer our readers for information which our limits prevent us giving.

In various localities within our district we have, then, three of the members of the Upper Silurian formation represented by our Limestones. The *Aymestry*, represented by the rocks of Sedgley; the *Wenlock*, by those of Dudley and Walsall; and the *Woolhope*, finding an equivalent in those of Hay Head, in the Barr Limestones.

The Aymestry Limestone.—This member of the Ludlow Rocks finds, as we have said, its equivalent in our Sedgley Limestone, and shows itself at Sedgley, at Turner's Hill, and at The Hayes, near The Lye Waste, about two miles from Stourbridge. It is at Sedgley we have by far the most important development of this limestone, which is thrown up in the form of a shallow basin or dish, in the hollow of which some Coal-measure sandstones are found to repose, as represented in the following section,* drawn from east to west across the two terminal out-crops of these Aymestry Rocks.



A Aymestry or Sedgley Limestone.
B Coal-measures.
C Lower Ludlow Shale.
D Wenlock Rocks.

This formation consists of a brown or blueish-grey argillaceous compact shale, the beds of which are thick and regularly jointed. Embedded in this shale is a band of dark brown nodular limestone some 20 or 25 feet in thickness—the Sedgley limestone, which has been for many years extensively quarried at various places along the line of out-crop.

The writer of this article is indebted to David Forbes, Esq., F.R.S., for the following analysis of this limestone :—

Carbonate of Lime	81·10
,, Magnesia	2·27
,, Protoxide of Iron	2·15
Alumina	0·45
Phosphoric Acid	0·21
Insoluble Matter	13·38
Loss in Analysis	0·44
	100·00

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* From the sections of the Geological Survey of South Staffordshire—sheet 24.

In order to verify these results another analysis was made, affording very corroborative numbers, viz. :—

Carbonate of Lime	81·33
" Magnesia	2·40
" Protoxide of Iron	2.01
Alumina	0·74
Phosphoric Acid	0·20
Insoluble Matter	13·32
	100·00

The specimens analysed were found to have a specific gravity of 2·75 at 60° Fahrenheit, and were taken out of the thick beds at Ellis's quarry, at Sedgley.

This rock differs considerably, not only in its lithological structure but in its organic remains, from our district representatives of the Wenlock limestones. It is much more compact, has fewer partings, and occurs in thicker beds, and contains fewer corals but many more shells. When freshly broken the colour is a blueish grey, but on weathering, or by the action of air and water, it acquires a more or less deep brown colour, due to the oxidation of the protocarbonate of iron which enters into its composition. When burnt it produces a dark-coloured lime, locally called the "Black lime," and makes a very durable stucco and mortar, particularly for hydraulic purposes. "If used in agriculture," says Sir Roderick Murchison, "its application should be limited to the light lands, which it enriches by its argillaceous as well as calcareous ingredients."

The limestone of *Turner's Hill* and *The Hayes* does not essentially differ from that of Sedgley, except that it is less abundant and of inferior quality, being still more argillaceous.

The quarries at present in work are those of Mr. John Ellis, Mr. Henry Newton, Mr. James Johnson, and Mr. Joseph Baker, Sedgley, and Messrs. Fisher Brothers, The Hayes, by whom also the lime is burnt in open kilns.

The Wenlock Limestone.—The equivalent of this limestone is found at Dudley, Dudley Port, and Rowley; Hurst Hill and Cinder Hill, near Deepfields; Rough Hay, near Darlaston; at Darlaston Green, Wednesbury, Walsall, and at Birchills, Rushall, and Daw End, near Walsall. Its exact depth below that of the Aymestry—or Sedgley—has not been ascertained. From data laid down under the Geological

Survey, Mr. Jukes thinks that the thickness of the shale, or bavin, which separates these two limestones may probably be 800 or 1,000 feet, and on this assumption he has drawn his Silurian section of the South Staffordshire field.

This limestone appears in our district as two bands of solid concretionary and flaggy limestone, called the *Thin* and *Thick* measures, separated by beds of shale more or less flaggy, with calcareous nodules and concretions. At the Wren's Nest, the *Thin* measure is upwards of 25 feet thick, separated by 96 feet of shale from the *Thick* measure of limestone of 39 feet. At Walsall the *Thin* measure is found to be from 10 to 12 feet thick, the intermediate shale from 120 to 135, and the *Thick* measure from 30 to 34 feet.

At the other places where these Wenlock limestone bands occur in the region about Dudley, it is said they differ very considerably, both in thickness and distance from each other, from those of the Wren's Nest, Dudley Castle, and Walsall. At Hurst Hill both the beds are thinner and nearer together. At Dudley Port, at Mr. Bagnall's pits, there are two limestone beds—the upper 27 and the lower 24 feet thick—resting one on the other.[*] Other workings in the neighbourhood also show, we are informed, great variations in the thickness and position of these limestone beds, but we are not able to state on reliable authority in what that difference exactly consists.

At Dudley and the Wren's Nest these measures of limestone have been thrown to the surface in a dome-shaped form, and have been extensively quarried in open workings. The stone is now obtained by tunnels driven from the old workings, as well as by shafts.

The following section,[†] drawn across the south end of Dudley Castle Hill and the centre of the Wren's Nest Hill, shows the way in which this formation occurs, and its limestone beds driven up in that locality.

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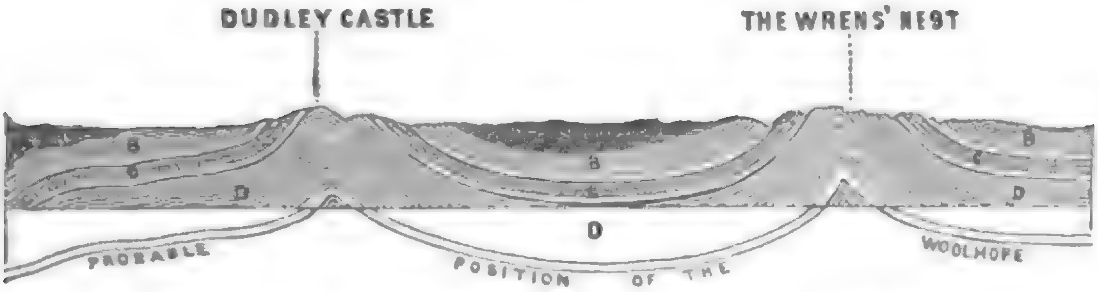
[*] The correctness of this statement, made on the authority of Mr. Jukes (see Geological Memoir of South Staffordshire—p. 107), I have reason to question. On making enquiry at the pit, I was informed by an old miner, of the name of Woodhouse, who was at the sinking of Mr. Bagnall's pit, and had worked in this mine, that the measure of stone is in two beds, but that their united thickness is only about eight yards. At Mr. Giles's pit, which is within a quarter of a mile of Mr. Bagnall's shaft, the same measure of eight-yard stone was got; and at a depth of about 80 feet below, another bed of limestone was reached, 12 yards in thickness. These two beds of limestone are doubtless the same as the two limestone bands which appear at Dudley, the Wren's Nest, and in the Walsall district; and I believe that the measure of limestone now being worked at Mr. Bagnall's pit is the same as the thin mine of the above, and that the thick measure of limestone will be found beneath, at about the same depth as at Mr. Giles's shaft.

[†] From the Geological Survey—sheet, No. 24.



A Coal-measures.
B Lower Ludlow Shale.
C Wenlock Limestone.
D Wenlock Shale.

We are again indebted to Mr. David Forbes for the following analysis of the thick measure of this limestone of Dudley and the Wren's Nest:—

The Dudley Castle Stone.—A compact limestone, of a dirty greyish colour, and having a specific gravity of 2·70 at 60° Fahrenheit, is generally very fossiliferous, and is interstratified with partings of shale. The least fossiliferous and most homogeneous part chosen for analysis afforded the following percentage results:—

Carbonate of Lime	90·09
„ „ Magnesia	1.26
Alumina and Sesquioxides of Iron... ...	2·30
Phosphoric Acid	0.46
Insoluble Matter	5·13
Water, Organic Matter, and Loss	0·76
	100·00

"The insoluble matter, as in the Sedgley stone, appears to be nothing but shale entangled in the limestone. Although the alumina and iron were not determined upon separately in these analysis, I have no doubt but that the iron is chiefly present in the state of carbonate of the protoxide."

The Wren's Nest Stone.—This limestone comprises many fossils, more especially corals and trilobites, and is in comparatively thin seams, united into a large bed by thin shaly partings. It is of a blueish grey colour, and possesses a specific gravity of 2·67 at 60° Fahrenheit. From a specimen taken out of the centre of the thickest bed, the analysis made shows its percentage to be as follows:—

Carbonate of Lime	74·64
„ „ Magnesia	2.51
„ „ Protoxide of Iron	1·63
Alumina	0.75
Phosphoric Acid	0·35
Insoluble Matter	20·03
Loss in Analysis	0·09
	100·00

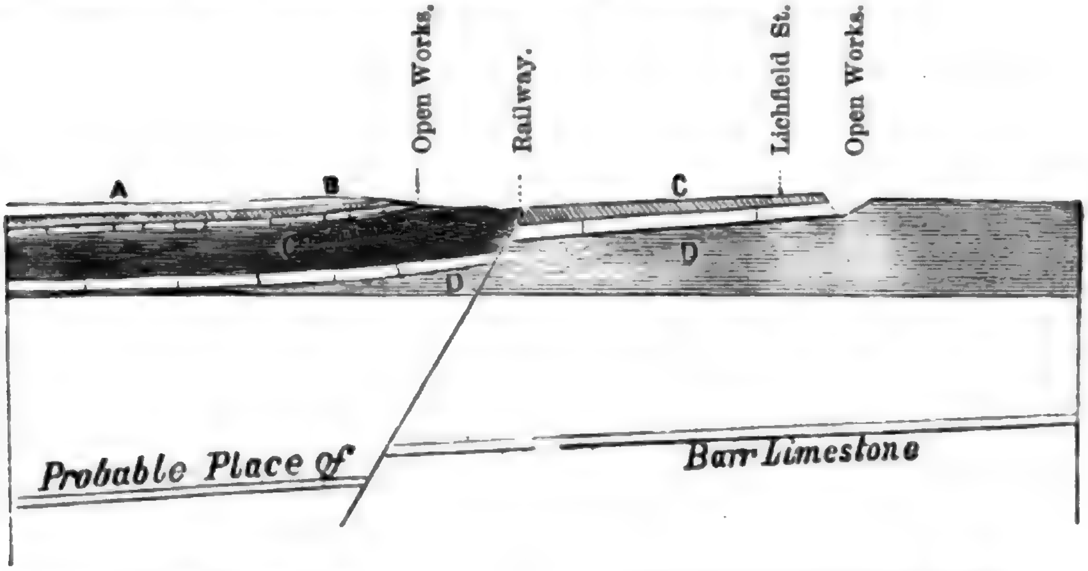
The insoluble matter was the same as in the Dudley limestone, and it is difficult to obtain even a moderately large hand specimen free from this intermixture.

Some very interesting results in the use of the Dudley limestone as a flux in the smelting of the South Staffordshire ironstone will be found in Dr. Percy's Metallurgy:—"Iron and Steel"—pages 544 and 545.

At Dudley Port, Cinder Hill, Darlaston, and Wednesbury, the stone is got by shaft. At Hurst Hill the two measures have been extensively quarried in open workings. They are however now practically abandoned, a little only of the thick measure, which is of very superior quality, being extracted at the present time.

The most important workings in this part of the field are those of the Earl of Dudley, at Dudley and the Wren's Nest. The other pits at present in work are those of Messrs. James Bagnall and Company, Messrs. Dixon and Burne, and Messrs. Simeon and Bradley, at Dudley Port; Messrs. Lloyds, Forsters, and Co., Old Park Colliery, Wednesbury; the Darlaston Green Steel and Iron Company, Limited, Darlaston; and Mr. Henry Hunt, Cinder Hill, near Deepfields. The stone is extensively used in South Staffordshire for fluxing operations, and also largely burnt for agricultural and building purposes.

At Walsall, Rushall, and Daw End, this limestone crops out at a gentle angle from beneath the Coal-measures, as represented in this section of the Walsall out-crops.



A Coal-measures.
B Lower Ludlow.
C Wenlock Limestone bands.
D Wenlock Shale.

The thick and thin measures of stone having been exhausted at the out-crops, the thick stone is now only obtained at Walsall and the Birchills, by shafts at depths varying from 60 to 90 yards. The pits at present in working are those of Mr. E. Crapper, Mr. John Brewer, jun., Messrs. Harrison and Webb, and Messrs. Thomas Matthews and Co., by all of whom the stone is also extensively burnt. Mr. Crapper has furnished us with the following analysis of the thick measure of his mine :—

Chemical Works, Wolverhampton, May 10th, 1864.

The following is the result of my analysis of this Limestone:—

Moisture	·40
Organic Matter	5·60
Carbonate Lime	76·40
„ Magnesia...	2·10
Oxide Iron	2·50
Silica...	13·00
	100·00

The above analysis shows this to be a limestone of excellent quality, which will yield when calcined a lime highly suitable for hydraulic and building purposes.

J. H. S. WILDSMITH.

At Rushall the workings are abandoned and now filled with water. At Daw End Mr. George Strongitham is quarrying both the Thin and the Thick measures of stone, the former used exclusively for fluxing operations, the latter burnt in open kilns and ovens, for building and agricultural purposes. Mr. John Brawn has also a shaft to the Thick mine of this limestone, by whom it is extensively quarried.

Mr. George Strongitham, of the Daw End Lime Works, has kindly furnished us with the following analysis of limestones extracted from his pits. The analyses are made by Dr. F. Wrightson.

The first specimen analysed is from the upper bed of the Thin measure of limestone, and was found to possess a specific gravity of 2·68 at 62° Fahrenheit, and afforded—

Carbonate of Lime	63·98
Alumina	1·00
Protoxide and a little Peroxide of Iron ...	5·17
Phosphate of Magnesia—0·91 Phosphoric Acid	1·70
Magnesia and traces of Alkalies	1·41
*Insoluble Earthy Matter	25·66
Loss on Analysis	1·08
	100·00

---

* Consisting of Silica and Alumina, Oxide of Iron, and traces of Lime and Magnesia.

The second specimen submitted to analysis was a piece from the centre of the Thin measure, used exclusively as a flux. It had a specific gravity of 2·70 at 62° Fahrenheit, and the following were the percentage results :—

Carbonate of Lime	95·38
„ Magnesia	0·31
Phosphate of Magnesia–0·208 Phosphoric Acid	0·39
Alumina	0·40
Protoxide and a little Peroxide of Iron ...	1·37
*Insoluble Earthy Matter	1·80
Alkalies and Loss on Analysis	0·35
	100·00

The third specimen analysed was taken from the centre of the Thick measure of limestone. The specific gravity was found to be 2·685 at 62° Fahrenheit, and the following its percentage constituents :—

Carbonate of Lime		93·17
Phosphate of Lime	0·24 Phosphoric Acid	0·52
Phosphate of Protoxide of Iron and a little Manganese and Alumina ...	0·86 Ditto ditto	2·51
	1·10	
*Insoluble Earthy Matter		3·72
Magnesia and Alkalies		Traces
		99·92

The limestones of Walsall and Daw End are used principally for building and agricultural purposes, in which a large trade is now being carried on at both places.

The Woolhope Limestone.—This limestone occurs at a certain depth below that of the Wenlock rocks, from which it is separated by beds of shale known as the Wenlock shale. In our district this shale, more or less flaggy and concretionary, chiefly of a rusty grey, sometimes of a bluish colour, rises from beneath the Wenlock limestone beds at Walsall, at a gentle angle to the east, ultimately throwing to the surface at Hay Head a series of limestone bands, locally called the *Barr*

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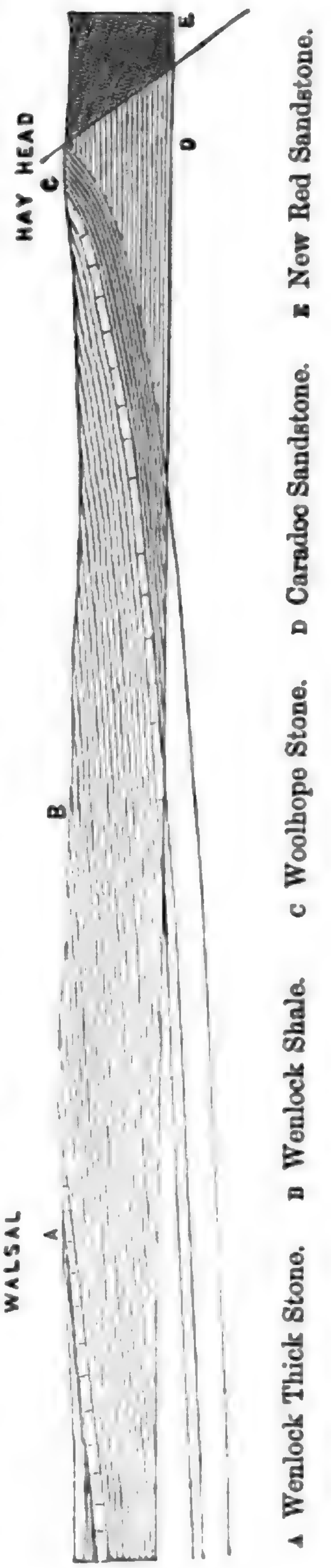
* Consisting of Silica and Alumina, Oxide of Iron, and traces of Lime and Magnesia.

Limestone. At one time some doubt existed as to the geological relation of these rocks—to which series they belonged. And to show the importance of an accurate local geological knowledge, and how, if the professional geologists were consulted, much useless labour and expenditure of capital might often be saved, we may mention that only a few years ago, a shaft was driven to a considerable depth below the limestones of Hay Head in the hope of reaching those of the Wenlock series. Now, as these are stratigraphically above those of the Hay Head series, it was perfectly absurd to sink below them for the Wenlock stone. Yet this was done, and of course resulted in failure. These rocks at Hay Head, there can be little doubt, are the equivalent in our district of the Woolhope beds, whose place in the geological series is at the base of the Wenlock formation. And this is further borne out in the occurrence in the immediate neighbourhood, and a little to the east of the Hay Head out-crop, of the Caradoc sandstone, the base rock of the Upper Silurian series. The annexed diagram shows the way in which these several rocks occur, and are thrown up to the surface on the eastern boundary of our field.



A Wenlock Thick Stone. B Wenlock Shale. C Woolhope Stone. D Caradoc Sandstone. E New Red Sandstone.

The thickness of shale which separates the Hay Head limestones from those of Walsall,—presuming the dip from Hay Head to Walsall to be at a mean angle of 5°—may be estimated at about 900 feet.

The stone has been extensively quarried all along the line of out-crop at Hay Head, as well as by underground excavations near to the Three Crowns. But all these workings are now abandoned.

Some years ago the Rev. T. B. Adams, of Aldridge Lodge, sank a shaft in the low ground a little to the west of the out-crop. The following section of this sinking has been sent us by F. F. Clarke, Esq., the present proprietor of the mine :—

	FT.	IN.	
Shale or Bat	20	0	
Thin Nodular, and Flaggy Beds ...	3	6	
Shale, &c.	33	0	
Captain Stone	1	2	Not worked.
Shale	0	1	
Middle Stone...	1	9	
Shale, &c.	3	0	
Flag	0	4	Six-foot Stone. Worked.
Shale	0	1	
A.—Captain Stone	1	2	
Shale	0	1	
B.—Middle Stone	1	9	
Shale	0	1	
C.—Bottom Stone	2	6	
Shale, &c.	15	0	

The following analyses of the limestones of this working were made by Dr. F. Wrightson :—

A.—CAPTAIN STONE.

*Insoluble Matter	22·58
Oxides of Iron, determined and reckoned as Peroxide	2·55
Alumina	2·30
Phosphate of Lime—0·41 Phosphoric Acid	0·90
Carbonate of Lime	70·00
Magnesia and Alkalies	1·21
Moisture, Organic Matter, and Loss	0·46
	100·00

B.—MIDDLE STONE.

*Insoluble Matter	26·35
Oxides of Iron	1·21
Alumina	1·70
Phosphate of Lime—0·707 Phosphoric Acid... ...	1·54
Carbonate of Lime	67·38
Magnesia and Alkalies	1·03
Moisture, &c., and Loss	0·79
	100·00

C.—BOTTOM STONE.

*Insoluble Matter	17·90
Oxides of Iron	1·55
Alumina	2·13
Phosphate of Lime—0·35 Phosphoric Acid... ...	0·77
Carbonate of Lime	75.85
Magnesia and Alkalies...	1·40
Moisture, &c., and Loss	0·40
	100·00

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* Composition of Insoluble Matter :—

Alumina and Oxides of Iron	15·30
Silicic Acid, and Silica	77·10
Magnesia, Alkalies, and a little Lime	7·60
	100·00

The oxides of iron, the magnesia, and alkalies were evidently derived from the clay, the sample, representing the bulk and not the pure limestone, being rough and weathered. The analyses were made with a technical object.

Mr. David Forbes has kindly furnished us with an additional analysis of the Bottom Stone, C., of this series.

It is a grey compact limestone, and was found to possess a specific gravity of 2·69 at temperature 60° Fahrenheit, with the following percentage composition :—

Carbonate of Lime			80·29
,, ,, Magnesia			3·65
,, ,, Protoxide of Iron			3·49
Alumina			0·35
Phosphoric Acid			0·10
Insoluble Matter	Silica	9·66	12·12
	Alumina, &c.	2·46	
			100·00

The value and importance of these limestones, though very limited in thickness and extent as compared with those of Dudley and Walsall, have, we venture to say, never been properly tested or appreciated in a commercial point of view. As a flux in the smelting of iron, owing to the small percentage of phosphoric acid, these limestones may be regarded as the best which our district affords for such operations. In addition to this, they are known, experimentally, to supply a most valuable and durable hydraulic cement, a cement for all hydraulic purposes perhaps unequalled by any in the country.

With respect to all these limestones of our district, the following note, which we think it well to print with our short notice of these rocks, was appended by Mr. Forbes to his several analyses :—

"As all the limestones are extensively employed in the iron smelting of the district, the importance of an accurate knowledge of their chemical composition must be sufficiently obvious. It would seem, however, that the subject had not attracted that amount of attention which might have been expected. It could be of little avail to employ iron ores and fuel free from phosphorus (if such could be obtained) if we employ as a flux, in the smelting operations, limestones often containing a very considerable amount of that so deleterious element, which could not other than greatly injure the quality and value of the iron produced. As far as the analyses go, Hay Head limestone would appear the best, and next the Sedgley, as a flux in iron smelting."

REPORT ON THE IRON TRADE OF SOUTH STAFFORDSHIRE, 1865.

BY JOHN JONES, F.G.S.,
Assistant Secretary to the South Staffordshire Ironmasters' Association.

HISTORICAL ACCOUNT.

At the present time the mineral district of South Staffordshire and East Worcestershire is entitled to rank as the oldest iron manufacturing centre. This important trade was one of remarkably slow growth, considering the vast quantities of coal and ironstone which the British rocks have contained. It is well known that the Romans were acquainted with the principal spots where iron ore could be obtained, and they also manufactured iron extensively, as is evident from the mounds of scoriæ and cinders containing Roman remains which have been discovered in the Forest of Dean and other districts.* The English manufacture seems to have been first located in Sussex, where the abundance of wood afforded facilities for smelting the ores which are found in that district. Camden states that this county was, in his time, "full of iron mines everywhere, for the casting of which there are furnaces up and down the country;" he also mentions Yorkshire and South Staffordshire as iron-producing districts. At this period the ore was reduced entirely by means of charcoal, and hence large quantities of wood were annually consumed in the neighbourhood of the iron furnaces. The rapid destruction of forest-land caused by this manufacture naturally produced some apprehension as to the future supply of fuel for general purposes, and in order to economise the wood, various legal enactments were put in force. About this time, however, the attention of Dud Dudley, a Staffordshire ironmaster of that period, was directed to the feasibility of using pit-coal instead of charcoal for smelting purposes. The town of Dudley had, even at that early period, attained to some importance as a manufacturing centre, nails, horseshoes, locks, and iron being extensively made in the vicinity. The substitution of coal for wood charcoal in the iron furnaces was first attempted at Dud Dudley's furnaces, on Pensnett Chase, and afterwards at Cradley, where a furnace was erected in which pit-coal was exclusively consumed. But reverses of various kinds prevented the development of the iron trade, notwithstanding the important discoveries which Dudley had made. His new method of smelting iron enabled him to manufacture the finished article much cheaper than the charcoal masters could, and hence all his undertakings were met by a determined resistance on the part of the neighbouring manufacturers. The elements, also, seemed to war against him, for a great flood, unprecedented in the history of the district, swept away his works at Cradley. These he quickly replaced, but the hostility of the charcoal masters succeeded in driving him from place to place, so that he had little chance of following up the important discoveries which he had made. We find him establishing a furnace at Himley, then another near Sedgley, where he asserts that he succeeded in turning out seven tons of iron per week. His new works were, however, scarcely completed, when a mob, instigated by his opposing manufacturers, attacked the place, and quickly laid the whole in ruins. For many years this persecuted inventor passed a chequered existence. He repeatedly solicited the Crown to grant him a renewal of his patent; but the civil wars diverted general attention from manufactures and commerce, and we find Dudley doing active service in the Royalist cause. Soon after the Restoration, he again settled in Staffordshire, at Green's Lodge, Kingswinford, and he states that near it were four forges—Green's Forge, Swin Forge, Heath Forge, and Cradley Forge, where he was practising his "perfect invention."

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* Scoriæ, supposed to mark the site of Roman ironworks, has been found near the Old Church, West Bromwich.

Plot states that after Dudley's experiments with pit-coal, a German, named Blenstone, built a furnace at Wednesbury, in which coal was used instead of charcoal; but this attempt does not appear to have been successful, and the iron trade of the district continued to languish more and more, as the supplies of wood decreased, until the greater part of the iron used in the country was imported from Spain and Sweden. About the middle of the 18th century, however, the application of pit-coal for smelting purposes was successfully carried out at Coalbrookdale by Abraham Darby, who introduced the process of cokeing the coal previous to putting it into the furnace. The next important era in the trade was the improvement of the blowing apparatus, which quickly followed the invention of the steam engine. With abundance of available fuel, and with increased means of reducing the ore, it is not remarkable that the iron trade soon began to revive, while the make of charcoal iron rapidly diminished. In 1788, South Staffordshire had not a single furnace making charcoal iron, while it had nine furnaces where pit-coal was used, though they must have been on a small scale, as they only produced about 15 tons of iron each per week. The number of charcoal furnaces in other parts of England was 24, and of those using pit-coal 44; so that even at this time the iron trade was not nearly so extensive an industry as it had been before the Commonwealth. The last ten years of the 18th century were remarkable for the great impetus then given to the iron trade, which about that time began to settle down in most important coalfields of the country, and to assume very the nearly the same geographical limits which it at present occupies, with the exception of the newly developed North of England districts. Thus we find, in 1796, that furnaces were in operation at Apedale and Silverdale, in North Staffordshire; in Cumberland, Derbyshire, Gloucester, Hereford, South Wales, Yorkshire, &c. In Shropshire, the discoveries of Abraham Darby, and the growing fame of the Coalbrookdale Works, led to the establishment of many furnaces in that locality. We find Old Park, Horsehay, Lightmoor, Coalbrookdale, Madeley Wood, Ketley, Shedshill, and Donnington Wood given as the list of Shropshire iron furnaces; together with others which are no longer in operation. At this time South Staffordshire is represented as having 14 furnaces; and it is noticeable that among these were several of much greater capacity than were the earlier furnaces. The following is the list:—

Level	1	Graveyard, near Dudley	1
Brierley Hill	1	Dudley Port	1
Duffield	2	Tipton	2
Bilston	2	Gospel Oak	1
Bradley	3		

The rapid development of this important industry towards the close of the 18th century, may be mainly ascribed to the discoveries of Cort and others, by which the processes of puddling and rolling iron were satisfactorily accomplished. Though Cort's patents date from 1784, yet the influence of his inventions was not extensively felt until some years later. At the commencement of the present century, we find that the list above given had been increased by the erection of the following blast furnaces:—

Tipton	2	Brierley Hill	1
Tipton Bloomfield	2	Wolverhampton	1
Wednesbury	2	Dudley Wood	5
Duffield	1	Bilston	1
Gornal Wood	1		

In the year 1806, an attempt was made to impose a duty of 20s. per ton on pig iron, and the ironmasters of that day combined to resist the tax. From the statements which they then prepared, it appears that there were then 222 blast furnaces in Great Britain, of which 162 were in blast. In this district there were 42 furnaces, producing each on the average about 1,600 tons of iron per annum.* From this period up to 1829, there are few improvements to record; but in that year the substitution of hot for cold blast marks a most important era in the iron trade. This invention is due to Mr. Neilson, of Glasgow, and to it may be ascribed the rapid development of the manufacture of Scotch pig iron, as before that time the rich black bands which it yields could only be reduced with considerable difficulty. At this period the number of blast furnaces in this district had increased to 123, and of these 39 had been built since 1823. A careful examination of the various works in operation at that time shows that the principal existing blast furnaces were then represented. At this time South Staffordshire was making above one-third of the pig iron produced in the whole country, and was converting the greater portion into merchant iron. The average yield per furnace was much higher than it had been early in the century, so that it is clear much larger furnaces were being erected. Since 1830, the number of blast furnaces has increased to 188; but leaving out those which are not likely to be again worked, the number of furnaces in this district may be put down at 170. During this period, however, other iron producing districts have risen into importance, so that the relative amount of iron smelted in this locality is much lower than it was thirty years ago.

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* A few years later, or about 1811, Mr. Hall introduced certain important improvements in puddling, by the use of tap-cinder and iron bottoms for the furnaces. This process is generally termed "pig-boiling," and is the method now universally adopted in the manufacture of finished iron.

The following list of blast furnaces is made up to this date :—

	Furnaces Built.	Furnaces in Blast.
Barber's Field, Bilston	2	2
Birchills, Walsall	2	0
New Birchills, Walsall	5	2
Bloxwich, Walsall	2	0
Bradley, Bilston	2	2
Brettell Lane, Stourbridge	2	2
Broadwaters, Wednesbury	3	2
Borverux, Bilston	7	0
Bilston Brook, Bilston	3	2
Chillington, Wolverhampton	4	5
Moseley Hole	3	0
Bentley, Walsall	2	5
Capponfield, Bilston	3	3
Gold's Hill, West Bromwich	2	2
Conygree, Dudley	3	3
New Level, Brierley Hill	3	3
Cape, Smethwick	1	1
Corbyn's Hall, Dudley	4	3
Corbyn's Hall New, Dudley	4	2
Corngreaves, Birmingham	6	4
Coseley Hall, Bilston	2	2
Crookhay, West Bromwich	4	2
The Lays, Stourbridge	3	2
Darlaston Green, Wednesbury	3	3
Deepfields, Bilston	3	2
Dudley Port, Tipton	2	0
Dixon's Green, Dudley	1	1
Park Lane, Tipton	2	0
Dudley Wood, Dudley	3	2
Groveland, Tipton	1	1
Hallfields, Bilston	1	0
Hatherton, Bloxwich	2	1
Herbert's Park, Bilston	1	1
Horseley, Tipton	2	2
Ketley's Dudley	4	0
Old Level, Brierley Hill	2	0
Millfields, Bilston	4	3
Netherton, Dudley	2	2

	Furnaces Built.	Furnaces in Blast.
Netherton New, Dudley	2	2
Stour Valley, Tipton	2	2
Oak Farm, Kinsgwinford	2	0
Oldbury	4	3
Old Hill, Dudley	2	0
Old Park, Wednesbury	3	3
Osier Bed, Bilston	3	2
Park Head, Dudley	2	1
Parkfield, Wolverhampton	5	5
Pelsall, Walsall	2	1
Priestfield, Wolverhampton	3	3
Priestfield New, Wolverhampton	2	0
Prior's Field, Bilston	3	2
Rough Hay, Darlaston	3	2
Russell's Hall, Dudley	5	1
Shut End, Kingswinford	4	3
Spring Vale, Bilston	3	2
Stonefield, Bilston	1	0
Stow Heath, Bilston	4	2
Tipton	2	2
Tipton Green	4	4
Wednesbury Oak, Tipton	3	3
Union, West Bromwich	3	3
Willenhall	3	3
Willingsworth, Tipton	3	2
Wolverhampton	3	2
Woodside, Dudley	3	2
Withymoor, Dudley	2	2
Windmill End, Dudley	3	3

THE ORES USED IN THE MANUFACTURE OF IRON.

The iron manufactured in South Staffordshire is made from the following ores:—

a. The Native clay Ironstone of the district.
b. The Brown Hæmatite of North Staffordshire.
c. The Red Hæmatite of the Ulverston district.
d. The Brown Siliceous Hæmatite of Northamptonshire.
e. The Clay Ironstones of North Staffordshire.

In addition to the above, a considerable quantity—probably little less than 60,000 tons—of forge cinder is used by the makers of a cheap pig iron.

About two millions of tons of ore will be required annually in this district, and this is made up, as nearly as can be estimated, in the following manner :—

(a)	Native Mine	948,500	tons.
(b)	Brown Hæmatite	368,000	,,
(c)	Red Hæmatite	50,000	,,
(d)	Northampton ore	200,000	,,
(e)	North Staffordshire	180,000	,,
	Cinder	150,000	,,
		1,896,500	

According to the above estimate, it is apparent that more than one-half of the iron manufactured in this district is made from native ores. Of these there are several varieties, differing from each other a good deal in composition, and hence in value. The average yield of iron may be roughly taken as from 25 to 40 per cent of the ore, though occasionally it is higher than this. The following details of the ironstone measures of South Staffordshire are mainly taken from the Memoirs of the Geological Survey :—

1.—*Brooch Binds,* immediately beneath the Brooch coal. They contain ironstone only to the South-west of Dudley.

2.—*Pins and Pennyearth Ironstone,* underlying the Herring coal.

3.—*The Gubbin,* coming in below the Thick coal. This is one of the most widely diffused, and one of the richest of the beds of ironstone in the district.

4.—*New Mine or White Stone.*—Immediately under the Heathen coal is a light-coloured ironstone, occurring in large nodules in a bed of clay or clunch, and also in continuous bands.

5.—*Pennystone* is a partial band, coming below the above.

6.—*Fire-clay Balls,* occurring in large masses, surrounded with argillaceous matter.

7.—*Poor Robin.*

8.—*Gubbin and Balls Ironstone* occur between Wolverhampton and Walsall, under the Bottom coal.

9.—*Blue Flats,* under the Singing coal, is confined to the central portion of the district.

10.—*Diamonds Ironstone,* occurring near the bottom of the Eastern Coal-measure series in this district.

The varieties in these seams of ironstone are very great, and hence it is difficult to fix on any analysis of a single measure as representing the general composition of the same ore over the whole district. The elaborate analyses published under the auspices of the Geological Survey, and also those contained in Dr. Percy's volume on the iron manufacture, furnish full details relative to the general composition of the native ores.

The following analyses, however, illustrate the composition of the most important Ironstone measures in the series (from the Geological Survey) :—

GUBBIN, DUDLEY.

Protoxide Iron	... ...	46·30
Protoxide Manganese	... ...	1·44
Alumina	... ...	0·44
Lime ...	... ...	0·76
Magnesia	... ...	0·94
Carbonic Acid	... ...	30·44
Phosphoric Acid	... ...	0·74
Sulphuric Acid	... ...	trace.
Silica, Soluble in Acid	... ...	0·12
Bisulphide of Iron	.. ..	0·07
Water	... ...	1·38
Organic Matter	... ...	1·14
Ignited Insoluble Residue	Silica ... 10·17 Alumina 4·36	15·26
		99·03

GUBBIN AND BALLS IRONSTONE, DARLASTON.

Protoxide Iron	... ...	49·30
Peroxide "	... ...	3·61
Protoxide Manganese	... ...	0·86
Alumina	... ...	0·34
Lime ...	... ...	0·69
Magnesia	... ...	0·45
Silica ...	... ...	0·23
Potash	... ...	0·09
Carbonic Acid	... ...	32·05
Phosphoric Acid	... ...	0·23
Bisulphide Iron	... ...	0·13
Sulphide Zinc	... ...	1·27
Water...	... ...	0·66
Organic Matter	... ...	0·54
Ignited Insoluble Residue	... ...	9·42
		99·87

The Insoluble Residue contained :—

Silica	5·99
Alumina	2·71
Peroxide Iron	0·21
Lime	0·17
Magnesia	0·07
Potash	0·21
	9·36

Total amount of Iron......... 41·06

BLUE FLATS IRONSTONE, DARLASTON.

Protoxide Iron	42·34
Peroxide ,,	1·47
Protoxide Maganese	1·12
Alumina	0·59
Lime	3·89
Magnesia	1·48
Silica	0·35
Carbonic Acid	30·91
Phosphoric Acid	0·25
Bisulphide Iron	0·06
Water	1·01
Organic Matter	0·56
Ignited Insoluble Residue	15·50
	99·53

Insoluble Residue contains :—

Silica	10·82
Alumina	3·65
Peroxide of Iron	0·11
Potash	0·84
	15·42

Total amount of Iron......... 34·41

It is difficult to give what may fairly be considered average specimens of the native ores. They differ in composition very much even over limited areas, and many of the richer varieties are only partially distributed. The richer of the several kinds of ironstone enumerated are in considerable demand for the manufacture of mine pig iron—a term which has come into use since the importation of foreign ores, and the employment of cinder in the production of cast iron. It is evident that these native ores are now more extensively and exclusively used in the production of iron than was the case a few years ago, when a good deal of attention was devoted in this district to the manufacture of a cheap iron, instead of to the production of an article of superior quality, which it is well known South Staffordshire could do, if the native ores were reduced without being mixed with imported varieties. The superiority of the mine pig iron is shown by the prices it will always realise, which will be found considerably above the rates of other leading districts.

(b) The Brown Hæmatite of North Staffordshire, commonly termed Froghall Stone or "Hydrate." This important bed of ironstone occurs in the lowest portion of the true Coal-measures in the neighbourhood of Cheadle, and upwards of one-half the produce is sent into South Staffordshire. It consists of two principal varieties, the red and the black. The latter contains more bisulphide of iron than the former, and hence is inferior in quality. This ore contains in 100 parts about 53 sesquioxide iron, lime 14·61, carbonic acid 18·14, and yields of iron 36·98 per cent. It makes a superior quality of iron; and the lime which it contains is generally almost sufficient to flux the ore without the addition of limestone to the burden of the furnace.

(c) The Red Hæmatite of the Ulverston district is somewhat extensively imported into South Staffordshire. This mineral, the sesquioxide of iron, contains from 85 to 95 per cent. of peroxide of iron; of pure iron from 60 to 65 per cent.

(d) Shortly after the closing of the International Exhibition of 1851, Mr. S. H. Blackwell discovered extensive deposits of siliceous hydrated oxide of iron in the oolitic beds of Northamptonshire and the district round. The ores vary much in composition, but in general terms it may be stated that they contain from 25 to 40 per cent of iron. The sesquioxide of iron is combined with considerable proportions of lime and silica. Large quantities of Northamptonshire stone were imported into this district a few years ago; but it is not in great favour at the present time, as it is asserted by the trade that though it is cheap enough, yet it is not capable of yielding a first-class iron. Thus it seems probable the importation of this ore will gradually diminish; but on the other hand there are some manufacturers who turn their attention to the production of a cheap kind of iron, and they naturally consume a considerable quantity of the Northamptonshire ore.

The clay ironstone imported from North Staffordshire is of a superior quality. Several of the varieties yielding nearly 40 per cent. of iron. Some of the ores resemble the black bands of Scotland in composition, but they do not contain quite so much bituminous matter as the Scotch ores. Considerable quantities of the Red mine, termed Pottery mine, are also imported as "fettling" for the puddling furnaces.

It will thus be seen that the ores employed in South Staffordshire differ very much in chemical composition, and hence the iron produced must also vary in composition and in value. Indeed almost every variety of pig iron is manufactured in this district; though the majority of the leading firms devote their attention to the production of first-class mine pig iron.

In addition to the above-mentioned ores, a large proportion of the "tap cinder," the slag produced in puddling iron, is used in the blast furnace, in combination with a greater or less proportion of ore. The economical use of the cinder, which was formerly a waste product in the iron manufacture, originated in this district. Mr. Benjamin Gibbons, of Corbyn's Hall New Furnaces, being the first to employ the forge cinder in the manufacture of pig iron. For foundry, and many other purposes, this iron is particularly applicable; but when converted into malleable iron it proves a very inferior article.

COAL.

The South Staffordshire Coalfield contains several seams of valuable fuel within a short distance of each other, and one measure in particular has made the district famous for concentrated mineral wealth. The Ten-yard coal is, as its name implies, about 30 feet in thickness, though generally the actual amount of workable fuel is not more than 26 to 28 feet. This valuable bed of coal is composed of various well defined layers, differing from each other very much in structure and composition; but the whole measure is very highly valued for iron smelting purposes. The Heathen coal is also extensively employed in the blast furnaces. New Mine coal is not so well adapted for iron smelting, as it contains a considerable quantity of sulphur, but it is now extensively used. The South Staffordshire coal is all of a non-coking quality, so that it may be used to a considerable extent in a raw state. It is, however, generally converted into coke; but the process usually adopted is of a somewhat primitive character. Of late years a good deal of attention has been devoted to the coking processes, and hence the wasteful method of preparing fuel for smelting purposes is now superseded by much more economical methods of making coke. In some cases a number of heaps are worked in connection with one stack, into which all the gaseous products are conducted. In others coking ovens are extensively adopted, and the small coal of the district is converted into coke of a superior quality by admixture with pitch, or a small proportion of the Welsh coking coal. A very successful method of converting the Thick coal slack—a commodity which it is generally difficult to deal with satisfactorily—into coke was invented by the late Mr. A. B. Cochrane, and is now exclusively adopted at the Woodside Works. A process has also been recently brought out for coking the Heathen coal slack, and this produces a very hard and superior kind of coke. As a rule the South Staffordshire coal is remarkably free from impurities, and hence it is peculiarly adapted for the manufacture of a high-class iron.

Sulphur, a common impurity in coal, is only present in the Thick coal in the proportion of about 0·75 per cent. The same coal yields on the average about 2 per cent. of ash. The immense quantities of Thick coal and other slack now lying useless on the pit mounds would be of great value if some economical process could be discovered by which this material could be converted into coke. The methods at present adopted necessitate the importation of Welsh coal, or the employment of a considerable proportion of tar, and thus the cost of converting into coke is somewhat expensive. The antiquated arrangements of the South Staffordshire furnaces render it next to impossible for the manufacturers to adopt such improvements in coking as would enable them to use up the valuable matter which at present escapes into the air, but which might be made available in calcining the ore, heating the blast, or in the puddling furnaces, &c. In many cases there are no means of putting the coke hearths near the forges or furnaces, and the introduction of new processes would necessitate the erection of expensive ovens and numerous modifications in existing arrangements.

LIMESTONE.

This essential mineral is found in considerable abundance in close connection with the Coal-measures, though it does not belong to the carboniferous series. The South Staffordshire Coal-measures repose directly upon the Upper Silurian rocks, which form a series of eminences between Dudley and Sedgley, and also occur in the neighbourhood of Walsall. It is generally supposed that what is now the central portion of England was dry land during the deposition of the Devonian and lower carboniferous rocks, and thus the true Coal-measures repose upon the upper members of the Silurian system. The Wenlock limestone, which is the only distinct limestone used in the blast furnaces, consists of an upper and lower band, separated by a considerable thickness of shale and bavin. The thin, or top limestone, is employed in the iron manufacture, and it is owing to the extensive demand for this mineral that the hills near Dudley have been so completely honeycombed by mining operations. This stone is now chiefly obtained by ordinary shafts, which penetrate the lower Coal-measures and catch the limestone at no great depth from the surface. The stone itself is a very pure carbonate of lime of a crystalline character, and remarkably rich in organic remains, which have rendered the neighbourhood of Dudley classic ground to the geologist. The supply of native limestone has, however, so far decreased of late years that large quantities of this mineral are annually imported from Wenlock, and also from the carboniferous limestone deposits of North Staffordshire and Wales. The total amount of limestone used in the blast furnaces of the district per annum, is probably about 250,000 to 300,000 tons.

DESCRIPTION OF FURNACES.

As this is the oldest existing iron-producing district of any importance it is to be expected that it will have many signs of its antiquity in the construction of its smelting furnaces. It has already been shown how slowly the iron trade developed itself in this county, and that for more than a century after the successful smelting of iron by means of pit coal it was customary to make use of only small furnaces in the reduction of the ores. Some of these older furnaces still remain, and attest the general character of the furnaces which were built even half a century ago. Hence it arises that there is a great dissimilarity between the furnaces of even a single group. Large and small, modern and old varieties, frequently standing side by side. Isolated little furnaces capable of making only about 100 tons per week, and having all the appurtenances on a most expensive scale, are by no means uncommon. The majority, however, are in groups of three, and are of average capacity, running from 130 to 150 tons per week. The largest furnaces in the district make from 180 to 250 tons per week; but there are very few in this class. Nor is the general opinion of the district in favour of large furnaces for the quality of ores used in South Staffordshire. The internal form of the furnaces also varies considerably. In some few the shaft is the same diameter through the greater part of the height. Generally, however, the diameter gradually increases from the top to about three-fifths of the depth, when it is rather rapidly contracted to form the boshes. The materials are chiefly raised by means of an inclined plane upon which a set of waggons are made to move, usually by the agency of a small stationary engine. Hydraulic and pneumatic lifts are employed in a few cases. The latter method is decidedly the safest—though it is liable to frequent derangements—which can be adopted. The various methods which have been devised for taking off the waste gases, and using the same to heat the blast or the engine boilers, have not been extensively introduced in this district. There are at present about 20 furnaces using the waste gas or "sulphur," as it is popularly called. The flame is carried off by means of a cast-iron cylinder dropped some depth below the furnace mouth. That there is a considerable saving of fuel by the adoption of this plan there can be no doubt; but many practical men believe that the economy in slack is not sufficient to compensate for the heavy expenditure in putting up and in maintaining the apparatus in working order. But nevertheless it seems highly probable that the utilisation of the waste gases will be generally adopted throughout the district in the course of a few years. Plans which appear to have been successfully introduced in one or two places for drawing off the waste gases by means of fans, and others creating a rapid current of air through the materials of the furnace, have not yet been introduced into South Staffordshire, though the matter is in contemplation, as it is only reasonable to infer that this method must lead to the production of a much higher temperature in the blast furnaces than can be obtained by the existing method, and hence that the reduction of iron under these circumstances would be much more rapidly and economically performed.

The hot blast is now almost universally employed, though there is considerable difference in the temperature to which the air is raised. In many cases both hot and cold air are supplied through separate tuyeres. There are only about six furnaces in the district where no appliances for heating the blast are in existence, and which thus produce cold blast iron exclusively. This quality of iron is much valued for certain special purposes, such as for the best varieties of rolls, &c. The make per week is of course much less than with the hot blast.

PRODUCE OF PIG IRON.

The total number of firms in this district at present engaged in the manufacture of pig iron is 58. Of the 170 available blast furnaces in the district, the number at present in blast is 119, and these yield in the average 14,945 tons per week, or about 125 tons for each furnace. After making deductions for repairs and irregularities in the working, the annual produce of pig iron may be fairly estimated at 740,000 tons, or about 28 per cent. of the make of the whole of England, or 15 per cent. of the produce of Great Britain. There does not appear to have been any considerable increase in the production of pig iron since 1849, as about that time there were 127 furnaces in blast, and the annual make is put down at 725,000 tons. The total number of blast furnaces in 1852 is given as 159, which indicates that a considerable number have been built since that time; but it is not unlikely that the above return was not correct as to the total number of furnaces. Probably not more than 20 new furnaces have been erected since the above-mentioned date. The present production of iron is not nearly sufficient to supply the requirements of the district, even for the manufacture of finished iron alone. Including the iron used for foundry furnaces,. there must be little short of 300,000 tons of pig iron imported annually into South Staffordshire.

PRODUCTION OF FINISHED IRON.

Though the fame of South Staffordshire as an iron producing district has somewhat diminished, owing to the rise of the Cleveland Centre, and the erection of furnaces in various other localities, yet it still stands foremost among the localities now making finished iron. In respect to its forges and mills, as well as its blast furnaces, it bears ample internal evidence that is a rather old-fashioned district. It cannot show many of the modern extensive works, arranged on the most improved plans, and giving employment to several thousands of people. Its forges and mills are scattered over the whole coalfield, and stretch out in certain directions a considerable distance beyond its limits. The forges even which Dud Dudley owned are still devoted to the manufacture of iron; and by far the greater portion of the principal works have been in existence much in the present state for a long period. The extent of the production of finished iron in this locality may be gathered from the fact that, were all the works in operation, nearly 20,000 tons of iron could be turned out per week. The total number of puddling furnaces is above 2,100, or nearly one-third of the number in the United Kingdom. These furnaces belong to upwards of 100 firms, some of which, as will be seen from the following table, are doing business on a very extensive scale, while a considerable number work only a few furnaces—

Forges having	less than	....		10	Puddling	Furnaces	28
,,	between	10	and	20	,,	,,	37
,,	,,	20	,,	30	,,	,,	14
,,	,,	30	,,	40	,,	,,	8
,,	,,	40	,,	50	,,	,,	5
,,	,,	50	,,	60	,,	,,	1
,,	,,	60	,,	70	,,	,,	2
,,	,,	70	,,	80	,,	,,	2
,,	,,	80	,,	90	,,	,,	1
,,	,,	90	,,	100	,,	,,	1

In connection with the manufacture of finished iron, mention should be made of the introduction of what is termed the "boiling" process in puddling, and which is now generally adopted in this country. This important improvement in Henry Cort's process is due to the late Mr. Joseph Hall, of the firm of Barrows and Hall. The modifications in the system of puddling which he successfully carried out mainly consisted in the application of calcined tap cinder, technically termed "bull dog," for fettling purposes, in place of the sand bottoms previously used. In the modern plan of puddling by "pig-boiling," considerable labour is saved, and the trying work of the puddler is much simplified, while a larger quantity of iron can be operated upon in a given time than could be done under the old process. Very few improvements in puddling have been introduced since the above invention, though any means of satisfactorily dispensing with the laborious work now performed by the puddler, and substituting for it an effective mechanical or chemical method of removing the impurities from cast iron, would be a great boon to manufacturers, and also to the men. Several experiments in this direction have been recently made in the district; but it is not possible at present to estimate the value of the change proposed.

The finished iron produced in South Staffordshire is for the most part of a very superior quality. The manufacture is chiefly confined to sheets, for boiler, engineering, and ship-building purposes; bar iron, for general use, and for chains and cables; nail rods, tin-plate sheets, and hoops. Very few rails are turned out, as a high quality of iron is not in much demand for railway use. Experiments have proved that the best iron of this district is capable of resisting a heavy strain, and in point of quality it may be classed as little inferior to the Bowling and Lowmoor brands. The extensive nature of the manufacture of finished iron carried on in the Black country may be estimated by the following statistics :—

Number of Puddling Furnaces	2,100
Produce of Finished Iron per Annum	855,000 tons.
Annual Wages paid in production of the above	£1,068,000
Average Number of Persons employed in Forges and Mills	17,000

MANUFACTURE OF STEEL.

There is not a large quantity of steel manufactured in the district. The total number of connecting furnaces for the production of blistered steel is not above 45. This branch of the iron manufacture is however on the increase. Puddled steel is made by one or two firms to a small extent. The Bessemer process has also obtained a footing in the district, as it is now carried on at the Old Park Works, Wednesbury. This firm was among the first to obtain a license for the manufacture of steel on Mr. Bessemer's plan, and has been producing a considerable quantity of the material for upwards of two years, though, the demand being at present limited, they have not produced so much as their apparatus was capable of turning out. As, however, the excellence of the material becomes more widely known, the demand will doubtless increase very considerably.

WAGES.

As a general rule, the persons engaged in the different branches of the iron manufacture earn good wages. The custom in the trade is to base the rates of payment in the several departments upon the recognised price of bar iron, as determined at the quarterly meetings of the manufacturers. The nominal payment for puddling is one shilling per ton for every pound in the price of bar iron; but, owing to various circumstances, it is now one shilling per ton above the regulative rates, nor is it likely that any attempts will be made to fall back upon the old standard. The wages in other departments oscillate 10*s*. for each change of a shilling in the price for puddling. The net earnings per head in an ironworks of ordinary size may be roughly estimated at about 28*s*. to 30*s*. per week, though there will be some among the number who will earn from £2 to £4 each, and some few more even than this. The above facts have been obtained by an examination of pay-sheets in connection with the principal ironworks. These wages are paid upon what is called five "turns," or days, per week. The question of wages has been the fertile source of many serious disputes between masters and men in this district, and especially during the last few years. South Staffordshire has, indeed, obtained an unenviable notoriety of late owing to the severe labour contests, which have brought so much distress upon the operatives, and have to some extent diverted trade from the manufacturers. The causes of these difficulties are, however, easily determined. The depressed state of the iron trade about eight years ago had the effect of driving many of the workmen to seek for employment in chain and other trades, so that when the demand for iron began to increase, there was a great scarcity of men. Before this state of things had been remedied by the natural course of events, many new ironworks were established in the North of England, in North Staffordshire, and in other places. In each case South Staffordshire was regarded as the nursery which would supply the skilled men to carry on their new works; and, in order to induce puddlers and others to leave their homes and family connections, higher wages were freely offered. This gradually led to an agitation for similar remuneration in the parent district; and the result was, that gradually the expense of producing iron in England became so considerable that foreign makers began to compete for our iron trade, and sent large importations of finished iron into our principal ports. Thus it was necessary to reduce the cost of manufacturing iron, and as this was mainly a question of lowering the rate of wages so much per cent., a series of struggles ensued, which resulted in the cheapening of production. The rapid extension of the iron trade of the country has not been accompanied by a corresponding increase in skilled labourers; but the high wages which are to be earned in this employment, and the comparative ease with which any workman of average intelligence can learn all that is necessary to enable him to take his place in nearly any department of an iron-works, is rapidly remedying the deficiency in the labour market. Considering the position of South Staffordshire with regard to its means of exporting its produce, it might be expected that the rate of wages would be lower than in districts more favourably situated; but even were this so, there are many points in favour of the men in this district, as rents are low, and provisions cheap, and the means of inter-communication are easy.

FUTURE PROSPECTS OF THE DISTRICT.

South Staffordshire is an old district, and its supplies of coal and ironstone have been undergoing a wasteful drain for a long period. Many persons who have contemplated the comparatively large areas over which the Thick coal and principal limestones were worked out, and the limited extent of new ground to be opened up, have been led to speculate upon the speedy decline of the iron trade of this important district. Their apprehensions have naturally been made use of by the new competing districts, until it has become the fashion to regard this iron-producing centre as on the eve of certain eclipse. But a careful consideration of the resources of the existing coalfield, and of the probable extension of the area underneath the red rocks which surround it, must dissipate the erroneous notions which have recently been so industriously circulated. Since the last meeting of the Association, many square miles have been added to this productive mineral district, and every year is marked by extensions in some direction or the other. Upwards of one-half the pig iron is still made of native ore, and there are abundant supplies of Brown Hæmatite and other ores within a reasonable distance. The manufacture of pig iron has not decreased during the past fifteen years, notwithstanding the rise of the northern and other districts. The production of finished iron must have greatly increased, for many puddling furnaces have been built during that period. Not only is one third of the malleable iron manufactured in South Staffordshire, but a very large proportion of this is used up for local purposes. For chains, cables, and anchors alone, upwards of 60,000 tons of best iron ore are annually consumed, and between two and three thousand persons are engaged in this manufacture alone. Many thousands are also engaged in nail-making, for the supply of nearly all the markets of the world. Anvils, bolts and nuts, bedsteads, bridle bits, stirrups, and general saddlers' ironmongery, rolls and heavy machinery, edge tools, fenders and fireirons, files, fire-proof safes, gas and other tubes, gun barrels, hammers, railway appliances, hinges, hollow ware, bridges, roofs, tin-plates, keys, locks, latches, rivets, screws, boilers and gasometers, wheels and axles, trays, vices, and iron wire, form extensive industries in the district, employing thousands of people, and using up large quantities of iron. These facts confer special importance upon South Staffordshire, and will also tend to make the manufacture of iron the main feature in its industry; for, though any particular branch of the hardware trade should be either depressed or become extinct, the variety of manufactures carried on will keep up an extensive demand for iron. The district itself, too, possesses remarkable facilities for carrying on its internal trade to the best advantage. It is intersected by numerous railways, affording communication to the principal seaports. The Canal which threads the district in and out has direct routes and branches extending upwards of 150 miles. The turnpike roads are unequalled by those of any other part of the kingdom, and allow of easy approach to all the important works. With respect to the export trade, however, its position is not so satisfactory as could be wished. The Canal rates are based upon liberal principles; but the various Railway Companies continue to impose tariffs which are most seriously affecting the commercial prosperity of the district. The rates are at present considered too high in nearly every direction, and advances have been recently made equal to 12½ per cent. on former charges. The importations of pig iron, minerals, coal, and coke are enormous, and it is manifestly the interest of the Railway Companies to foster this traffic. All the new districts have great advantages in carriage, as they are near to the coast, and therefore can in some degree command the foreign markets. A few years ago South Staffordshire had almost the entire north of Europe trade, but it cannot now compete with Middlesbro' in this respect, as the railway rates to Hull are very high. The London market is now severely contested by the northern manufacturers, and this year it has even been supplied with Belgian and French iron. Thus it appears that ere long the cost of carrying will affect very largely the welfare and probable existence of certain branches of manufacture in the district. To suppose that the branches of trade enumerated above will all be driven away seems impossible; but when the cost of iron is much enhanced, either by carriage or other reasons, the manufactures in which it is employed will follow it. As the prospects of this district are so intimately connected with the railway tariffs, a short examination of the existing rates may be useful.

Taking the rate to Swansea (10*s.* per ton), distant about 170 miles, it may be assumed that this is a remunerative charge, as there are no special circumstances to make the charge exceptionally low. The rate to Liverpool (84 miles, or half the distance to Swansea,) is also 10*s.* per ton. This inequality is even more apparent in the case of Chester (64 miles) and Manchester (74 miles), where the rate equals that to Swansea. The rate to Cardiff (126 miles) is 9*s.* 2*d.*, while to London, which is equally distant, the rate is nearly double (17*s.* 6*d.*) The charge per ton per mile to different ports is shown in the following table:—

				s.	*d.*		*d.*	
Bristol	100	miles	rate	10	0	per ton	1·02	per mile.
Liverpool	84	,,	,,	10	0	,,	1·43	,,
Cardiff	126	,,	,,	9	2	,,	0·88	,,
Hartlepool	200	,,	,,	17	6	,,	1·05	,,
Glasgow	275	,,	,,	20	0	,,	0·09	,,
London	126	,,	,,	17	6	,,	1·68	,,

From the above it appears that the rate to London is 89 per cent. above Glasgow, 60 per cent. above Hartlepool, 91 per cent. above Cardiff, 18 per cent. above Liverpool, and 40 per cent. above Bristol. In connection with the arbitrary rates charged to this district, it may be mentioned that the tariff from Warrington to London is only the same as from this district. From Middlesbro' to London, above 200 miles, the rate is 18*s.* 4*d.*, compared with 17*s.* 6*d.* from this locality. These anomalies are exercising a most prejudicial influence upon the trade of this district, and forcibly suggest the advisability of some species of Government control in regulating railway tariffs, so that a vast industrial centre like this, with a large proportion of the capital of the country invested in its manufactures, may not have the foundation of its trade destroyed by the arbitrary proceedings of the railway managers in whose hands its traffic must rest.

Though the manufacture of iron in this country has increased so rapidly during the last ten years, especially in the new districts, the demand for this material has increased in a corresponding ratio, so that the development of the modern producing centres does not imply the decline of any existing district. Some years ago, it was estimated that the consumption of iron in Great Britain was equal to 25lbs. per head upon all the population; while at the same period America was taking 16lbs., Belgium, 12lbs., Prussia 10lbs., France 8lbs., Italy, Russia, and Turkey 6lbs. At the present time, on the lowest computation, the manufacture is at the rate of above one hundred weight per head for Great Britain.

SOCIAL CONDITION OF THE PEOPLE.

There has been a good deal written about the social condition of the ironworkers of South Staffordshire, but most of the accounts are exaggerated one way or the other. The nature of the employment induces a generally rude external appearance, and the strain upon the physical energies leads them as a rule to live expensively, and to drink excessive quantities of stimulants. They are singularly improvident as a class, and though they obtain good wages, they have a remarkable genius for spending all they earn, while they devote but little attention to their home comforts. They are vivacious pleasure seekers, and hence Saint Monday is observed as a general district holiday. Their general bearing is calculated to create an unfavourable impression, as their language and manners are unpleasantly uncouth. But, on the other hand, there are many redeeming features in their character. They are extremely hospitable and kind to each other, and if any one is unfortunate, they willingly assist him out of his difficulties—not by loans, but by gifts outright. They appear more interested in giving their children some education than do the miners of the district, who are singularly apathetic in this respect. They are also a generally well-conducted body of men, as was apparent in the late dispute. Unlike the miners, they did not resort to any unseemly demonstrations or violent speeches, but met quietly together, and talked matters over, and throughout the struggle not a single case of unruly conduct was reported. The employers were never molested in any way, and so admirably did a considerable number of the men comport themselves in connection with the complicated aspect of affairs at that time, especially the higher class of ironworkers, that it seems probable the district will not again be troubled with an unfortunate struggle like the one mentioned for many years to come. The men mostly belong to sick and benefit societies; but they are generally but sorry affairs, and are too often found to fail when the members most require assistance. The manufacturers have devoted much attention to providing for the religious and educational wants of their men. Several ironworks have extensive schools and churches attached to them. In a few cases missionaries are employed to visit the men and their families. The whole district is well supplied with schools and places of worship, and for the encouragement of the former, the ironmasters have a prize scheme, and award annually between two and three hundred pounds to the most deserving pupils in each. Though frequently disappointed in the results which appear to arise from philanthropic efforts of various kinds, the numerous agencies by which attempts are being made to elevate the social and moral condition of the people are well supported, and compare not unfavourably with other manufacturing districts. In all these respects great advances have been made during the last fifteen years, and, though much remains yet to be accomplished, there is reason to hope that each year will be marked by a further elevation of the social condition of the people who are engaged in the staple manufacture of South Staffordshire.

LOCKS AND LOCK-MAKING.

By J. C. TILDESLEY.

The manufacture of locks and keys has long occupied a prominent position among the skilled industries of South Staffordshire, especially in the localities of Wolverhampton, Willenhall, Wednesfield, Walsall, and the adjacent hamlets. In the two former places it may be said to constitute the staple trade, and in the latter it forms no unimportant part of the industrial enterprise of the people. Apart from local considerations, this branch of handicraft, from its remote antiquity, its skilful achievements, and its great and growing commercial importance, presents a most interesting subject of enquiry.

The great antiquity of locks and keys is proved by frequent allusions both in the works of ancient classical writers, and also in the pages of Holy Writ. Aratus, in his description of the constellation Cassiopeia, states that in shape it resembles a "key," the stars to the north composing the curved part, and those to the south the handle. In those early ages, keys were invariably curved in the stem, and the handle was usually composed of brass or ivory. The poet Ariston, in his *Anthologia*, applies to a key the epithet ***Βαθυκαμπτη***, *i.e., one that is much bent.* According to Eustathius, these keys in shape resembled a sickle, and were so large that they were not unfrequently carried on the shoulder, as reapers carry their sickles in these days. This statement is confirmed by Callimachus in his *Hymn to Ceres,* where he represents the goddess assuming the form of Nicippe, her priestess carrying a key *superhumalem* or "fit to be borne on the shoulder." In Homer's *Odyssey* (xxi) we read that the well known heroine, Penelope, took "a brass key very crooked and tipped with ivory," wherewith to open the wardrobe.* The passage is thus rendered in Pope's translation :—

> " A brazen key she held, the handle turned,
> With steel and polished ivory adorned ;
> The bolt, obedient to the silken string,
> Forsakes the staple as she pulls the ring,
> The wards respondent to the key, turn round,
> The bars fly back, the flying valves resound,
> Loud as the bull makes hill and valley ring,
> So roared the lock when it released the spring."

Pliny and Polydore Virgil ascribe the invention of keys to Theodore of Samos, but this is refuted by other authors, who mention these articles as having been in use before the Siege of Troy.

In the sacred writings reference is made to keys in Judges (chap. iii, ver. 25), and in Isaiah (chap. xxii, ver. 22), and locks are mentioned as having been used in the rebuilding of Jerusalem by Nehemiah (chap. iii, ver. 6).

The credit of inventing the first lock is due to Egypt, and there is reason to believe that the invention is now more than 4,000 years old. The Egyptian lock, which even now is not entirely obsolete, is thus described by Mr. E. B. Denison, Q.C. :— " In this lock, three pins fall into a similar number of cavities in the bolt when it is pushed in, and so hold it fast; they are raised again by putting in the key through the large key hole in the bolt, and raising it a little, so that the pins of the key push the locking pins up out of the way of the bolt. The security afforded by this lock is very small, as it is easy to find the places of the pins by pushing in a piece of wood covered with clay or tallow on which the holes will leave their impress, and the depth can easily be ascertained by trial." They were for the most part made of wood, but occasionally they were constructed of iron or copper. Rude representations of these locks, found sculptured among the *bassi relievi* which adorned the grand old temples of Karnak and the Herculaneum, prove their antiquity, and at the same time reveal the astonishing fact through all these lapse of years they have undergone no material alteration either in form or construction.

Next in antiquity to the Egyptian lock, "warded" locks take rank, being mentioned in early missals and other manuscripts, from the commencement of the Christian era.

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* Eustathius, (a Greek commentator on the works of Homer,) remarks that this kind of key was very ancient, and differed from the keys having several wards, which were invented after, but that those ancient keys, known as "serpent keys," were in use in his time, A.D. 1170.

In early times they were mainly constructed of metal, and not unfrequently contained some complicated secret as to the introduction of the key. The Mediæval age produced some of the finest specimens of warded locks ever seen either before or since that period. These locks were remarkably chaste in design, and elaborate in execution. We have before us a sketch of an ancient *Serrure de Tabernacle*, manufactured in Gaul, which throws some light on the character of locks in the middle ages. The escutcheon surrounding the key-hole is surmounted by a representation of Our Saviour, and on either side are the figures of two angels. The other parts of the lock are most elaborately engraved, the edges being lined with beads and scrolls. The key is finished with corresponding symmetry, and the whole presents a combination of art and handicraft such as is rarely witnessed in modern manufacture.

Another ancient lock, in which the security is derived from levers, or "tumblers," is of Chinese invention. Tumblers differ from wards in being *moveable* instead of fixed obstructions to any but the proper key. This description of lock mentioned in an old Chinese book as "having sliders and tumblers of different lengths," was originally made of wood, and has been for centuries in extensive use throughout the celestial empire.

The only other lock of antiquity to which we need refer is the letter lock, or combination padlock. This lock is so constructed that the letters of the alphabet, which are engraved on four revolving rings, may by pre-arrangement be required to spell a certain word, or number of words, before it can be opened. Although apparently complex, the security of this lock is in reality very small, and the invention has long been regarded as more curious than useful. It is supposed to be a Dutch invention, and is some centuries old. A Dutch writer, Vanhagen Von Ense, attributes the introduction of the letter lock to M. Reignier, a French locksmith of considerable repute at the close of the 17th century; but it is evidently of much more remote origin, for in Beaumont and Fletcher's play of *The Noble Gentleman*, which was printed in the year 1615, it is thus alluded to :—

> "A cap case for your linen and your plate
> With a strange lock that opens with A.M.E.N."

In some verses by Carew, dated A.D. 1620, we find also the lines :—

> "As doth a lock
> That goes with letters, for till every one be known
> The lock's as fast as if you had found none."

Reignier, however, enjoyed the distinction of being the original inventor, and for many years his locks were in great request, the couriers' despatch boxes being generally fastened with them.

Upon these four ancient locks, the Egyptian, Warded, Tumbler, and Letter, the foundation of all modern improvements and inventions connected with the lock trade appear to be based.

For the introduction of locks into England, we are indebted to those Phœnician merchants who traded with the Cornish miners in the days of Britain's infancy. The Egyptian lock was the first thus introduced, and it is a singular and interesting fact that articles of the description given by Mr. Denman, may still be found in the Faroe Islands, and in some parts of Cornwall and Devon.

No reliable information exists as to the period at which locks were first manufactured in this country, but it is conjectured that rude specimens were produced by British artisans before the time of Alfred. As early as the 12th century, English locks were considerably ornamented and tolerably secure. From the 14th to the end of the 16th centuries they were still more elaborate and complicated productions, partaking somewhat of the excellence displayed in the manufacture of the swords and shields for which the smiths of that period acquired such well deserved renown. A specimen of the 14th century manufacture may be still seen in the parish church of Snodland, in Kent. The principal keyhole of this lock is covered by a plate of strong but ornamental iron, which shuts over it as a hasp, and is secured by a second key. In Winchester Cathedral also is a lock produced in the 16th century. This article is very massive and made entirely of metal, mounted with elaborate brass ornaments. The working and interior part is let into the door, the ornamental portion only being exposed. In the Booke of the Accounts of the Manor of Savoy," published during the reign of Richard I., an entry records the purchase of "two stocklokkes, price xx*d.*, and two hange lokks (pad locks), price xvj*d.*" The "Durham booke," bearing date A.D., 1531, contains a locksmith's bill for two stocklocks, at fourpence each, and three pad locks, at twopence each. In estimating the prices of locks at that period, however, the comparative difference ln the value of money should not be forgotten.

Latch-keys—to which Materfamilias has such an aversion—were invented before the 16th century, as was proved during some recent excavations at Salisbury, where a number of these articles were found. In the 17th century, a profusion of art was displayed in the manufacture of locks. The handles of keys especially became greatly elaborated, being so entirely composed of scrolls and ornaments that they bore some resemblance to net work. In the centre of the bow was usually inserted a Cross, a very common ornament at that period. Mr. F. W. Fairholt, F.S.A., informs us, that early in the 18th century "key-handles were always elegantly decorated in patterns more or less intricate in proportion to the destination of the lock to which they belonged, whether it was for common security, or for the magnificent cabinets of the middle ages, the locks and keys of which were as elaborately worked as the furniture to which they were affixed.

Among the curiosities in the shape of locks and keys which have appeared from time to time, may be noticed the following.

During the reign of Queen Elizabeth, one Mark Scalist, a smith, is said to have constructed a lock, "consisting of eleven pieces of iron, steel, and brass, all of which, with a pipe key, weighed only two grains of gold."

In the year 1640, some mechanical genius invented the first detector lock, which is thus described by the Marquis of Worcester in his *Centurie of Inventions.* "This lock is so constructed that if a stranger attempt to open it, it catches his hand as a trap catches a fox, though so far from maiming him for life, yet so far marketh him that if suspected he might easily be detected." A steel barb appears to have been concealed inside the key-hole, so that if any person should in ignorance overlift a certain tumbler, the barb would be forced by a spring through the key-hole into his hand. It is related that while testing this lock, the patentee was himself accidentally visited by the barb, a circumstance which would doubtless inspire him with implicit confidence in the efficacy of his invention.

On the door of a room at Mr. Throckmorton's, in Northamptonshire, where the poet Cowper spent many of his reflective hours, was a brass lock of superior workmanship and quaint design. The principal feature of the ornamentation consisted of a *mezzo relievo* figure of a man clad in jerkin and a cavalier's hat, and holding a gun as if in the act of watching against a surprise. By means of a small pin, one of the legs of the figure was made to move, disclosing the key-hole. Towards the right hand was a dial face, closely studded with double rows of figures, also an inscription with the maker's name:—

"Johannes Wilkes, Birmingham."

The style of the costume of the figure would point out the date of the lock as towards the end of the 17th century.

In Miss Mitford's delightful *Recollections*, there is a notice of a lock at Ockwell's Hall, near Taplow, of extraordinary dimensions. It was fixed on an iron studded door, and was several feet in length. The key was of such gigantic proportions that only the strong arm of a man could wield it, and turn the massive bolt.

Locks of peculiar construction were formerly made in connexion with "iron bridles," which superseded "cucking stools," as a punishment for scolds or refractory women. In many of the ancient boroughs, these iron bridles were frequently used for that purpose, and were secured on the offender by lock and key, after the manner of gyves and leg locks. The comparative state of perfection attained by the fair sex in these days, however, has brought bridle locks into disuse, and that branch of manufacture is now quite extinct.

We come now to consider briefly the inventions and improvements in the construction of locks during the past century. The first patent for a lock was granted A.D. 1774, since which time the number of patentees has been augmented to more than 120. From this bewildering catalogue we propose to select a few of the more important in the order of their seniority.

Almost the first lock patented after the establishment of the patent law was one which has rendered its inventor famous in the annals of locks and keys. Mr. Robert Barron, of London, a mechanic of considerable ingenuity, obtained for himself, in the year 1774, the right of constructing locks in which the security was effected by fixed wards, with the addition of lifting tumblers or levers. This invention was at once received with favour, and is still in great demand, being both useful and secure. In the original lock were two tumblers, and this number is now generally introduced. These tumblers are kept in their proper position by a steel spring; attached to the tumblers are studs, which retain the bolt in its locked position; and it is only by the application of its own key, which is cut in steps of different radii, to correspond with the varying lifts of the two tumblers, that the latter can be raised to the exact height to bring the studs into a line with the slot in the bolt, and thus allow the top step of the key to act upon the talon and unlock it. Any attempt to pick the lock is frustrated by a number of upper transverse notches in the bolt, which renders it impossible to tell when the tumblers are lifted to the required height.

In the year 1784, Mr. Joseph Bramah, of Piccadilly, London, patented a lock which has perhaps attracted greater public attention than any other to which we could refer. In this lock a sliding bar or bolt was fixed, in the edge of which was cut a number of notches. Into these notches are placed an equal number of small bars, so as to prevent the motion of the bolt until their removal was effected. This could only be done at their extremities, no other part being exposed, and these ends have always an equal projection when the bar is set fast. It is only, however, when each small bar has exactly received its due motion that the large bolt can be set at liberty, and when the pressure of the key is again withdrawn they fall instantly into their respective notches and secure the bolt. In this lock a compound of both endway, pushing, and revolving motion is given to the key, instead of the simple rotary movement of Barron's lock. Although the Bramah lock differs entirely in form from the tumbler lock, its principle of action is precisely the same. In the tumbler lock there are a series of spring latches or tumblers, each of which has to be raised to a certain position to allow a pin or stump fixed to the bolt to pass; and in the Bramah lock, as we have observed, there is a series of slides, each of which has to be pressed down to a certain position so as to pass the locking plate before the bolt can be moved.

For many years this lock was exhibited in Mr. Bramah's shop window in Piccadilly, to which was attached a label with these words:—*Notice.*—"*The artist who can make an instrument that will pick or open this lock will receive two hundred guineas the moment it is produced.*" Among the thousands who were attracted from all parts of the world to the metropolis during the great Exhibition of 1851 was Mr. Hobbs, an American mechanician, who having noticed the challenge, eventually accepted it, and to the surprise of everybody succeeded, after sixteen days' perseverance, in opening the lock whose reputed security had almost passed into a proverb. The event created considerable public excitement, established Hobbs's fame, and gave a stimulus to the lock trade, such as it has never received before or since.

The original patent for Chubb's lock was obtained A.D. 1818, by Jeremiah Chubb, which has been modified and improved upon by the successive patents of Charles Chubb (1824), by Charles Chubb and Ebenezer Hunter (1833), by John Chubb (1846), and by John Chubb and Ebenezer Hunter in 1847. In the last patented lock are retained all the peculiarities of the former inventions, with many practical improvements and additions. It consists of six separate and distinct double-acting tumblers, with the addition of a "detector," by which any attempt to pick or open the lock with a false key is immediately notified on the next application of the proper one. The detector is the great and peculiar feature by which Chubb's lock is so well and deservedly known. It consists of a spring, which so long as the levers are lifted with exactness by the true key remains inactive; but should the levers, raised by a false key, vary in the slightest degree, this spring instantly secures the bottom lever, and renders the bolt immovable. When the true key is applied while the detector spring is "on duty," the former has to be turned the reverse way, and the spring restored to its original position, and the lever is then set at liberty. Chubb's locks, like the others to which we have referred, are made in series, having a separate and different key to each, and a master-key for opening any number that may be required. So extensive are the combinations, that Mr. Chubb assures us that it would be quite practicable to make locks for all the doors of all the houses in London, with a distinct and different key to each lock, and yet there should be one master-key to pass the whole! A most complete series of locks was constructed some years ago by the late Mr. Chubb for the Westminster Bridewell. It consists of 1,100 locks, forming one series, with keys for the master, sub-master, and warders. At any time the governor has the power of stopping out the under keys, and in case of any surreptitious attempt to open a lock and the detector being thrown, none of the under keys will regulate it, but the governor must be made acquainted with the circumstance, as he alone has the power with his key to restore the lock to its original state. Barron's, Bramah's, and Chubb's locks are made for all purposes, from the smallest cabinet to the largest fortress gate.

In the year 1830 a patent was granted jointly to Mr. James Carpenter, of Willenhall, and Mr. John Young, of Wolverhampton, for a lock in which the action of the latch bolt was perpendicular instead of horizontal. The patent subsequently became the sole property of Mr. Carpenter, with the exception of its application to mortice locks, which Mr. Young retained.

Mr. Carpenter afterwards improved the construction of all locks to which his patent was applied, so as to ensure smooth working and durability. The invention was very successful, and to this day "Carpenter's locks" are as familiar as household words in every market of the globe.

Another name of celebrity in the history of locks, is Thomas Parsons. His was the first "changeable" lock patented in England. The elevation of the tumblers in this lock is regulated by an adjusting screw passing through the lock to the inside of the door. This screw changes the positive but not the relative position of the tumblers, so that the same difference in the steps of the key must be retained, the change being made only in the length of the bit. The number of changes for each lock is consequently very limited. In a lock of ordinary construction from 15 to 20 distinct changes can be applied.

Mr. J. Sanders, of Burton, secured an invention in 1841, for a lock with traversing tumblers, instead of fixed levers as in Bramah's patent. In this lock the levers are raised with the key, and propelled with the bolt, through an accurate gauge which would act as an obstacle to any false key.

Mr. Hobbs holds as a fixed principle, that "wherever the parts of a lock which come in contact with the key are affected by any pressure applied to the bolt, that lock can be picked." In his patent, therefore, this is prevented by a simple addition to the tumbler stump working beneath the bolt.

Among the other patents which have survived, may be enumerated Summerford's double-acting draw tumbler, that is, a tumbler which is drawn down by the key, instead of being lifted up; Aubin's revolving curtain, closing the key-hole during the revolution of the key; Ballie's lock, with secret and secure fixings; and the patents of Cornthwaite, Duce, Walters, Price, Wolverson, and Carter. Alarum bells are attached to some locks, and others are so contrived that any attempt at violation would result in the loud report of an appended fire-arm, but as a rule these contrivances are more remarkable for ingenuity than for practical utility.

The introduction of the lock trade into South Staffordshire took place as early as the reign of Queen Elizabeth, but it did not flourish very extensively until the end of the 17th century, when it became one of the chief staple industries of the district. In the year 1660, when hearth money was collected, Wolverhampton paid for 84 hearths, and Willenhall for 97, most of which were used by the locksmiths of those times. The locks thus manufactured were purchased by chapmen who travelled from place to place with packhorses. At the commencement of the 18th century, however, the merchants began to establish store rooms in Wolverhampton and Birmingham, whither the locks and other hardware productions were conveyed by the smiths, in wallets,—or as they have been facetiously termed, "human saddlebags,"—a system not even yet quite obsolete.*

Dr. Plot, writing in 1686, says of Wolverhampton:—"The greatest excellency of the blacksmith's profession in this county lies in their making of locks for doores, wherein the artisans of Wolverhampton seem to be preferred to all others, they making them in suites, six, eight, or more in a suite, according as the chapman bespeakes them, whereof the keys shall neither of them open the other's lock, yet one master-key shall open them all. Nay, so curious are they in lockwork that they can contrive a lock that the master or mistress of a family sending a servant into their closets, either with the master-key or their own, can certainly tell by the lock how many times that servant has been in, at any distance of time, or how many times the lock has been shot for a whole year together, some of them being made to shew it 300, 500, or 1,000 times,—nay, one of the chief workmen of the town told me he could make one that should shew it 10,000 times. Further yet, I was told of a very fine lock, made in this town, sold for £20, that had a set of chimes in it, that could go at any hour the master should think fit. And these locks they make either with brass or iron boxes, so curiously polish't, and the keys so finely wrought, that 'tis not reasonable to think they were ever exceeded unless by Tubal Cain, the inspired artificer in brass and iron." Dr. Wilkes, writing a century later, pays an equally flattering tribute to the skill of Wolverhampton artisans, and mentions that the number of locksmiths in Wolverhampton at that time was 134. The lock trade of Wolverhampton is quite distinct from that of other parts of the district, their security being for the most part effected by tumblers or levers, while those of other localities are principally secured by fixed wards. The descriptions of locks chiefly manufactured here are known as cabinet, pad, rim, fine plate, and mortice, all of which are made both in iron and brass. One firm alone (Messrs. Chubb and Son) manufacture about 30,000 locks per annum, the cheapest of which is sold at 10*s.* nett, while many of them are worth from £2 to £3 each. The commoner descriptions of cabinet locks are, however, sold at much lower prices, varying from 3*s.* to 10*s.* per dozen, and are made in enormous quantities. Fine plate locks are those imbedded in wood cases, and are used principally for stable and yard doors. The ironwork of these articles is manufactured by artisans working at their own homes in the rural localities of Brewood, Coven, Pendeford, and other villages between Wolverhampton and Stafford, the addition of the wood case being made at Wolverhampton. The cheapest of these articles are sold as low as 6*s.* per dozen. The lock trade of Wolverhampton is rapidly extending, and the skill of its artisans is well sustained.

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* The oldest ware-room in Wolverhampton is that of Messrs. Tarratt, Sons, and Co., in the Townwell Fold, which has been established considerably more than a century.

Willenhall has for generations been celebrated for its locks and keys, and its artisans have acquired a considerable reputation for their ingenuity. In the year 1776, one James Lees, a workman in his sixty-fourth year, made a lock and key the weight of which did not exceed that of a silver twopence, and he expressed his readiness to make a dozen locks and keys the total weight of which should not exceed a silver sixpence. At that time the number of locksmiths in Willenhall was 148. The locks chiefly manufactured at Willenhall are similar in kind but of inferior quality to those produced in Wolverhampton, with the exception of the fine plate, which are not made here. Rim locks, *i.e.*, door locks opened with knobs and key, and having two or three bolts, are made in numberless qualities, and at prices ranging from 15s. per dozen to £1 each. They are chiefly made on the principle of Carpenter and Young's patent for export trade, and with the original horizontal motion for home trade. Dead locks are those which have only one large bolt, worked by the key, and do not catch or spring like rim locks. They vary in price from 5*s.* to 50*s.* per dozen. We are unable to explain the inanimate appellation applied to these locks, a name which would more appropriately describe mortice locks which are *buried* in the door. Mortice locks can be made on either the rim, dead, or drawback principle, but are higher in price, varying from 24*s.* to 100*s.* per dozen. Drawback locks are chiefly used for hall doors, and resemble dead locks, except that the bolt springs and is worked by a brass knob on the inside or by the key on the outside. Pad locks are too well known to need description here. They are made in enormous quantities, both in brass and iron, and at prices ranging from 6*d*. to £1 per dozen. Cabinet locks employ the manufacturing ingenuity of the outlying hamlets of Short Heath and New Invention,* but the articles produced are much inferior to Wolverhampton make. Willenhall locks are, as we have observed, all warded, the wards varying of course in strength and quality, known as common, fine, round, sash, and solid wards. One peculiarity of the lock trade at Willenhall is its distribution among so many masters, the majority of whom employ only some six or eight men and boys. This system has introduced a spirit of rivalry and competition, of which purchasers of locks have not been slow to take advantage, and the consequence has been to reduce the price in some branches to so low a point that excellence of workmanship has given way to rapidity of production, and this has doubtless given rise to the familiar saying that if a Willenhall locksmith happens to let fall a lock in the process of manufacture he does not stay to pick it up, as he can make another in less time. The late Mr. G. B. Thorneycroft, who resided at Willenhall for a time, was once taunted that some pad locks were made in Willenhall which would only lock once; but when he was told the price, namely twopence, he replied, "Well, it would be a shame if they *did* lock twice for that money." The same articles are now being sold at one halfpenny each!

At Walsall the lock trade has much extended during the past few years. Until recently, its operations in this branch were almost exclusively confined to cabinet locks, but now iron pad locks are made in great quantities, and within ten years the number of artisans has been doubled.

Wednesfield is chiefly noted in the lock trade for the manufacture of iron cabinet, and till locks, and various kinds of keys. Here, however, as at Walsall, the lock trade is only a supplementary branch of industry.

The following table, showing the various branches and localities, will serve to illustrate the present extent of the lock trade in the district:—

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* This hamlet owes its strange name to a simple circumstance. The tenant of the first house erected there was annoyed by a smoky chimney, and he contrived an ingenious apparatus to remedy the evil. It succeeded, and so pleased him that he invited the attention of every visitor to his "new invention" as he called it, a term which became so familiar that it was applied to distinguish his house, and as others sprung up the hamlet, for the want of a better, adopted it also.

Locality.	Description of Lock.	No. of Employers.	Approximate No. of Hands.	Average Weekly Earnings.
Wolverhampton	Best Till and Cabinet,	20	400	25*s*. to 40*s*.
	Levered Rim and Mortice, and Fine Plate	50	800	25*s*. to 40*s*.
Willenhall (including Short Heath, &c.)	Warded Rim, Dead, Mortice Drawback, Pad and Till	275	3000	18*s*. to 30*s*.
Walsall (including Bloxwich)	Iron Pad and Cabinet	35	400	18*s*. to 30*s*.
Wednesfield	Iron Cabinet and keys	50	200	15*s*. to 25*s*.
Brewood	Fine Plate	30	150	18*s*. to 28*s*.
	Totals	450	4950	

The total weekly production of locks in the district is estimated as follows:—Pad, 24,000 dozen; cabinet, till, and chest, 3,000 dozen; rim, dead, mortice, and drawback, 3,000 dozen; fine plate, 1,000 dozen; and secure levered locks and other descriptions, 500 dozen; being an aggregate production of 31,500 dozens of locks per week.

The principal markets to which locks are exported are Australia, New Zealand, India, China, Continent, South America, the Cape, and the United States. The two former are however by far the most important customers for door locks. For pad locks India is perhaps the greatest market, as regards iron pad, and the Continent for brass and ornamental pad locks. The French treaty has not yet benefitted the lock trade of the district to any considerable extent, and it will require time to assimilate the tastes of the two nations in this respect before the French consumers will abandon their own flimsy decorative articles in favour of plain practical English locks.

The American war affected seriously only two branches of the lock trade, the pad and cabinet departments. Thirty years ago the United States was by far the most extensive market for the lock trade,—indeed it was estimated that at one time more than one half of the locks made in this district were sent there. Now however, as for some years past, the States do not buy any but till and pad locks; and even these are gradually being made in their own market, together with other kinds, so that in time the demand for these also may be expected to cease. The late war therefore did not produce any very disastrous consequences in connection with the lock trade of the district, the demand from the Colonies and other markets being happily buoyant during the whole of that protracted strife.

The principal foreign rivals with which English locksmiths have to contend, are those of America, France, and Germany. The advantage possessed by the former is chiefly the fineness of the sand used in casting, which is so much superior to that used in this country that American locks and keys can be cast with such accuracy as not even to require the finishing touch of a file. This considerably reduces the expenditure of manual labour, and an artisan in the States recently wrote a letter to his friends in England in which he told them that he could make door locks at the rate of 150 per day, the average rate at which such articles in England are made being about one dozen per day. The locks made in America are, however, unenduring and insecure, and are not likely to injure the demand for English locks in other markets, although the latter have now little sale in America. The characteristic feature of Continental locks is their chasteness and elaborate decoration, in which our French neighbours, especially, greatly excel. Their locks lack, however, the strength and practical usefulness of English articles, and the latter do not yet suffer much from the competition, English locks being preferred in almost every market on the globe. It cannot be denied, however, that Mr. Ruskin's theory, on the union of art and handicraft, might be studied with advantage by the locksmiths of this district, to whose productions might be given increased symmetry and beauty, without in any way destroying their more practical qualities.

Perhaps no extensive branch of local industry has taken less advantage of the recent progress of mechanical science than the lock trade. In most cases they are constructed now in precisely the same manner as they were twenty years ago. To the fact of the trade being so much in the hands of small capitalists, must be mainly attributed the lack of that enterprise and progression which have characterised other departments of local industry. The recent spread of the lock trade to Lancashire, London, and other districts will, however, doubtless produce a change in the mode of manufacture here.

Neither (as we have just hinted) have locks and keys made in this district kept pace with the demand for decorative art workmanship, which is the natural result of the refining influence of an increasing civilisation, and the spread of education amongst the people. But although these drawbacks must in fairness be admitted, we may assert that the lock trade has not been exceeded by any other handicraft in the district for the development of individual ingenuity and persevering toil.

The condition of the artisans engaged in this branch of industry has much improved of late years, but there is still room for amendment. The average hours of labour are from 6 a.m. to 7 p.m. in summer, and from 7 a.m. till 8 p.m. in winter; but in too many instances these hours are exceeded. The employment of women in the trade is not extensive, the proportion being about 10 per cent., but boys are employed at very early ages. The apprentice system is by no means so general in the lock trade as was the case a few years ago. In 1841, the number of apprentices employed (chiefly brought from the Union Workhouses) in Willenhall and Wednesfield alone was 615, in 1851 this number had been reduced to 376, and in 1861 to 255. The treatment of these youths is also much more considerate and humane than when pictured by Mr. Disraeli in "*Sybil*" twenty years ago. As a rule the locksmiths work much steadier than was their wont in years gone by, although the time-honoured custom of "drinking the health of St. Monday" is still observed. In morals and intelligence they have improved as a class in proportion to the increase of educational and other advantages placed within their reach. In one lock factory, which may be taken as a fair example of the others in the district, 70 per cent. of the artisans are members of Friendly Societies, 50 per cent. can read and write, 15 per cent. are members of a Mechanics' Institute, 10 per cent. have accounts with the Post Office Savings Bank, and 5 per cent. are the owners of the freehold cottages in which they reside.

Of the future of the lock trade in this district we can speak with promise. The development of new empires, and the opening-up of fresh fields of commerce in our colonies, augur well for this department of local industry, and we have faith that the locksmiths of South Staffordshire will keep their place before all rivals. The demand for locks and keys must necessarily extend with the growth of civilisation, and it must also be maintained so long as lovers have secrets to treasure, and misers have hoards to keep, and affection has its sacred relics to preserve. But when the day dawns of which poets dream, and seers foretell—when the world shall rejoice in the millennium light, and resemble Longfellow's Arcadian village where—

> "Neither locks had they to their doors, nor bars to their windows,
> But their dwellings were open as day and the hearts of the owners;"

Then, but not till then, will our treasures need no more the guard of lock and key, and the locksmith, like *Othello*, "find his occupation gone."

BOILER PLATE WORKING.

By GEORGE PIGGOTT.

It is intended to treat in this paper of the manufacture of boilers and gas apparatus, under the head of boiler manufacture; and in addition to steam boilers, a great variety of other articles being included, such as sugar pans, clarifiers, salt and saltpetre pans, tanks and cisterns, galvanizing baths, plating vats, canal and river boats, iron roofing, &c.

The manufacture of gas apparatus, in addition to gas holders and tanks, includes all the various vessels and appliances required in complete gas works.

There are several boiler makers in Birmingham. The largest establishment in the town, that of Messrs. Thomas Piggott and Sons, is engaged in the combined manufacture of boilers and of gas apparatus.

Prior to 1831 neither of these trades was carried on in Birmingham, though both existed in South Staffordshire. When first established here, in 1831, the combined trades employed only about 30 men and boys, and the finished work reached about 150 tons yearly. In 1849 the yearly production had reached to about 500 tons, and in 1864 to upwards of 1000 tons; while the number of hands employed had risen in the same time to 200 men and boys.

About two-thirds of the whole demand is for the home trade, and one-third for export. The articles manufactured for the home market are chiefly steam boilers for stationary, locomotive, and marine engines; a great variety of steam-generating vessels for heating, drying, and evaporating purposes; galvanizing baths, plating vats, tanks and cisterns, iron roofing, gas-holders, purifiers, condensers, &c.

The foreign trade dates from 1836, but was quite inconsiderable till 1845. It is principally in sugar pans and sugar-making vessels, with steam engine, boilers, and fittings, for the West Indies, Brazils, and for the port of New Orleans; in gas apparatus of every kind for South America and the East Indies, and in gas-holders, and to a small extent in other articles for the whole of Europe. Extensive gas works to light the city and fort of Bombay have just been completed, the whole of the apparatus and iron roofing for which were supplied from the Spring Hill Works of Messrs. Piggott, and erected in Bombay by Birmingham workmen.

Many of the principal towns of Germany and France have been supplied with gas-holders from Birmingham, notwithstanding the heavy import duties levied on the materials. The new tariff in Belgium, Prussia, and the whole of the Zollverein, has reduced this duty to about £2 10s. per ton; the commercial treaty with France reduced the duty on imports to that country from £14 8s. per ton to £3 4s. per ton; but the tariffs of Austria and Holland afford the greatest contrasts, for while the former government, true to her protectionist principles, imposes a duty of £8 2s. 6d. per ton, the latter exacts no more than 1 per cent., *ad valorem*.

More than half the total of goods manufactured for the home and foreign markets is finished at the works; the rest, temporarily put together and marked at the works, is transported to its destination in parts which can readily be joined.

It is not usual in this trade that orders for large numbers of the same article are given; the following instances are exceptional:—As many as 414 sugar pans, and 450 small boilers for hot-water apparatus, have been supplied in one year.

No women are employed in this manufacture, nor boys under the age of twelve. The occupation is by no means unhealthy, work being chiefly done in well-ventilated sheds or in the open air. The wages of skilled workmen graduate from 4s. to 6s. per day. The general features of the trade and industry having been sketched in the foregoing introduction, the history of improvement in the finished article and in the processes of manufacture will form the remainder of this notice.

It may be remarked generally that all locomotive and marine boilers are now tubular, and nearly all fixed engine boilers are cylindrical in external form, and are constructed in various modifications of the Cornish principle.

In recording the progress of the gas-holder trade in Birmingham, it must be remarked that, at the period of its introduction here in 1831, the largest gas-holder then made was 60 feet diameter, and contained about 50,000 cubic feet of gas; this was a great advance in size when compared with those adopted by the first gas-light company in London about the year 1812; they had a capacity of only 10,000 cubic feet, and that was considered excessive and dangerous. In 1834 telescopic gas-holders were first brought into use, and the capacity of the vessel thereby doubled without any increase in the diameter. Mr. Stephen Hutchison, at that time engineer at the London Gas Works, Vauxhall, was the means of bringing this new gas-holder into notice, and Birmingham has the merit of having perfected this great and valuable improvement by mêans of which double or treble stowage is now obtained in the same sized tank, and, of course, upon the same area of land.

Several steam engine and other boilers of improved construction have been brought out here during the last twenty years. The most successful is one patented by Messrs. Turner and Hardwick. About 60 boilers have been made on this plan, all of which have proved satisfactory in economising fuel.

This improvement gave the 60 feet diameter gas-holder of 1834 a capacity of 100,000 cubic feet. In 1841, they had reached a diameter of 80 feet, with a capacity of 230,000. In 1845, a diameter of 100 feet and capacity of 330,000 was obtained. In 1852, a diameter of 120 feet and capacity of 500,000, and in 1858, a gasholder 162 feet in diameter, capable of holding 1,037,000 cubic feet, was made in Birmingham, and erected at Glasgow. Since that time gasholders of still larger dimensions have been made, and several are now at work in London containing nearly two million cubic feet of gas. Such have been the successful efforts of the trade to keep pace with the requirements of gas light companies consequent upon the enormous increase in the consumption of gas in all large towns.

It is observable that whilst the number of gas holders manufactured has decreased, the weight and capacity has increased. In 1837, there were 37 gas holders made in Birmingham, averaging 7½ tons each, and giving an aggregate capacity of 784,000 cubic feet; in 1864, 10 gas holders averaged 80 tons each, and gave an aggregate capacity of 3,137,000 cubic feet. There have been constant alterations in the construction of gas holders to meet the increasing dimensions and pressure required; the most recent have been in telescopic gas holders. Messrs. Piggott have invented a self-acting bolt which locks the sliding parts of the gas holder together as they become coupled by the hydraulic joint, and unlocks them as the parts of the gas holder become unconnected. It is found to be very useful where it is desirable to assimilate the pressure of the two lifts as closely as possible. They have also introduced a new and improved form of hydraulic cup made entirely of boiler plate, thus dispensing with the use of both single and double angle iron, and giving great additional strength to the periphery of the vessel in the parts where strength is most required.

The process of manufacture in this as in most mechanical trades has progressed wonderfully. Less than half a century back nearly everything was done by manual labour, now nearly everything is done by the aid of machinery. Formerly the boiler maker punched the holes in the plates by repeated blows with a sledge hammer on the head of a punch, and it required about five or six blows with a hammer 14 lbs. weight to punch a hole ⅝ inch diameter through a plate ⅜ inch in thickness. Screw presses were then used, and afterwards lever presses, combining a pair of cutters for shearing, were introduced, but still worked by manual labour and very slow in operation. It is about forty years since punching and shearing machines were generally driven by steam power. They punched one hole, and sheared about three inches in length at each stroke, and they were worked at from twelve to fifteen strokes per minute. These kind of presses are still in general use, very much improved both in power and speed. A lever press at the Spring Hill Works, capable of exerting a power of 200 tons, will punch twelve holes per minute three inches in diameter in a plate one inch thick, and by hydraulic power as many as 150 holes are punched at one blow, and plates are then sheared four feet in length at one stroke. For very accurate work drilling and planing has lately been sometimes substituted for punching and shearing plates and angle iron. Messrs. Cochrane, of Dudley, constructed a machine, when erecting the railway bridge over the Thames at Hungerford, which drilled 80 holes, 1 inch diameter, through a ⅝-inch plate, the entire 80 holes being drilled in fifteen minutes.

Before the introduction of rolled iron, the rivets for boiler making were made from square hammered bars; the iron was rounded to the size of the intended rivet in a tool on the anvil at a smith's fire, then cut off and headed in a tool, with a hand hammer, just as wrought iron nails are now made by hand. This mode of making rivets was continued long after the introduction of rolled round bars. One man could in this manner make about 300 rivets per day. The first machine for making boiler rivets was invented by Mr. Griffiths, of Smethwick, in the year 1838. Many machines for this purpose have since been made and patented by the inventors. One of the best is by Mr. Charles De Bergue, of Manchester. This machine will make 6500 rivets, ¾-inch diameter, in one day. Setting plates and putting them together used to be pretty nearly one process in boiler making, for each plate was formed to an approximate shape and then temporarily fixed in its place on the boiler whilst red hot. It was then and there hammered into its required form, and when cooled was marked for punching from the holes of the adjoining plates to which it had been fitted. Many rude contrivances were resorted to to place and keep the work in shape, and it was no uncommon thing for a boiler, when it was put together ready for rivetting up, to be so full of stretching screws to pull in one place, and props to push out another, that there was little space left for the holder-up man.

The plan almost universally practised now is to mark and punch the plates from patterns or templates, made correctly by striking out the work full size. Great accuracy is thus obtained; the plates fit to each other with perfect ease, and produce a boiler true and uniform in all its parts. After the plates are punched and sheared to the template they are set to the required shape; if intended for a cylindrical boiler or vessel they are rolled to the proper course without being heated; if they are required spherical or angular they are, if it is practicable, formed by hydraulic pressure, and various other mechanical means are now resorted to in setting plates and preparing angle iron, so that they are for the most part formed to the required shape almost without the use of the hammer. The punishment inflicted upon the fibre of the iron by the old clumsy method is thus avoided, and the work is completed with a neatness and truth contrasting wonderfully with the productions of a few years ago. The process of rivetting the plates together is now in part done by both steam and hydraulic power, but the machine has by no means superseded the old plan of hand rivetting, chiefly because no machine has yet been made capable of doing every kind of work.

The boiler maker of the present day reaps many advantages from the improvements made in the manufacture of iron; not in the quality, for that is deteriorated, but in the variety in form in which it is now made, and in the length of bars and increased size of plates produced. Going back to the period before rolled boiler plates were known, boilers were then made of hammered plates; they were about 2 feet long and 15 inches to 18 inches wide, and about ⅝-inch thick in the middle, tapered all round to ¼-inch thick at the sides. As it was only the thinned edges of the plates that could be punched, the boiler maker was compelled to put them in his work of the size and form that he received them from the forge, and it was usual to order a few "half plates," that is, plates of about half the ordinary width, to be used as closers in completing each row or circle of plates in the boiler, and this practice of using half plates was retained after the introduction of rolled iron.

All steam engines were at that time made on the condensing principle, and worked at 2½ to 3 lbs. pressure on the square inch in the boiler. The general form of boiler was what has been called the "balloon" shape. The upper part of this boiler being hemispherical was composed entirely of taper plates, but the boiler maker of that day was ignorant of the method of calculating, or by any way obtaining the proper taper for the plates, so he had to guess it, and it sometimes happened that the vertical joints got very far out of perpendicular in consequence of the plates being tapered too much, this he at once rectified by putting in a parallel plate, or if needful one with the wide end uppermost. The writer of this has seen a balloon-shaped boiler in which were several "half plates," and some plates reversed for the purpose of rectifying the excess of taper; the rivets were ⅝-inch diameter, made from square iron.

SOUTH STAFFORDSHIRE MANUFACTURES.

By JOHN JONES, F.G.S.

CHAINS, CABLES, AND ANCHORS.

THE manufacture of chains and cables is now principally carried on at Tipton, West Bromwich, and the district south-west of Dudley. It has been introduced about forty years. E. Billingham and his two sons made chains for London merchants, and for dealers in the neighbourhood of Dudley, about the year 1824. Shortly afterwards others began to make half-inch to two-inch cables. About 1834, the manufacture began to develop rapidly, and several capitalists devoted themselves entirely to the business, and made it a kind of factory trade.

The manufacture of anchors is a much more recent introduction. Mr. Hingley attempted this as early as 1838, but it was not until ten years later that he thoroughly established the trade. Before that time anchors were made in the neighbourhood of the principal sea ports. For the first few years no anchors were forged weighing more than 20 cwt.; but eventually, by the introduction of improved machinery, forgings weighing 74 cwt. were successfully turned out. This trade is now being rapidly extended, especially with the Australian Colonies, India, and Japan.

The only remarkable variety of anchor is that made for the Japan market, which has four grapnel arms. This promises to be an excellent market for chains and grapnels. The introduction of the steam hammer has tended very considerably to improve this manufacture, as much stronger and more reliable work can be turned out by its aid than under the old process with the sledge. One of the largest anchors made in this locality can be finished in a day, whereas formerly it took three or four days to complete the work.

Women are employed rather extensively in the light chain trade, but not in making cables.

In the various factories or chain shops, about 50,000 tons of chains and cables are produced yearly, representing an annual value of £650,000.

Upwards of 5,000 tons of iron is annually converted into anchors.

In addition to the above, 10,000 tons of iron will be used in the manufacture of trace and other small chains, chiefly exported to American markets.

In the factory works about 2,000 men and boys are engaged in making chains and cables, and 200 upon anchors. There are also nearly 300 small shops, attached to cottages, in which 2,000 men, women, and children make the smaller chains. On the average there is one man to every five engaged at the work. Children are extensively employed in this trade, and frequently make very long hours. The average earnings of men and boys in the factory trade is from 18*s*. to 20*s*. per week; but in the smaller shops the average is lower, as so many children are employed.

EDGE TOOLS.

Considerable quantities of scythes, edge tools, spades, shovels, agricultural tools, &c., are made in this district, and give employment to about 1,800 persons, nearly one-third being boys. This trade has been established in the district upwards of 200 years, but has been largely developed during the last 10 years.

ANVILS AND VICES.

Anvils and vices are made principally at the Lye, and near Dudley. It is estimated that at least 50 tons of iron per week is used in this manufacture.

HEAVY FORGINGS.

Another trade, forming now an important feature in the South Staffordshire district, is the manufacture of large forgings by the aid of the steam hammer. The largest hammer for this purpose is one on Condie's principle, erected at Messrs. Hill and Smith's, of the Brierley Hill Works. It is 5½ tons weight, and falls through 6-feet space, and is capable of forging a piece of wrought iron 20 tons weight, a piece weighing 14 tons having recently been forged under it. The hammered armour plates for Her Majesty's iron-clad Caledonia were manufactured at these works, where, besides the large steam hammer just mentioned, two others of a smaller size are employed, besides hammers of the old kind in use before the introduction of Mr. Nasmyth's principle, and which for certain purposes the steam hammer has not been able to displace.

AGRICULTURAL IMPLEMENTS.

The manufacture of agricultural implements in South Staffordshire was introduced about 25 years ago, by Messrs. Hill and Smith, of the Brierley Hill Works, who commenced exhibiting at the annual country exhibitions of the Royal Agricultural Society of England, when that now flourishing society was in its infancy, their various manufactures in field implements, fencing, gates, and hurdles, made from the iron produced in the district. The use of iron in agricultural implements was then so rare, and its cheapness and greater durability, when compared with wood, so manifest, especially in the various descriptions of iron fencing, farm gates, &c., that a demand for articles of this description at once sprung up, and has ever since been steadily increasing—a demand much increased by the publicity given to those manufactures by these annual exhibitions, and by the numerous premiums awarded by the Royal Agricultural Society to Messrs. Hill and Smith for them. It may be safely computed that at the present time the iron consumed in South Staffordshire in iron fencing, farm gates, hurdles, and such like articles, used for agricultural purposes, exceeds 10,000 tons per annum, as upwards of 4,000 tons are consumed by the above firm alone, and many other manufactories of similar articles have sprung into existence of late years in the neighbourhood of Wolverhampton, Bilston, &c.

FIRE-IRONS.

Fire-irons were first made in Dudley about 120 years since; at this period they were of rather a rude description. The designs and construction have altered considerably since that time, and much improved.

The increase of make since 1849 has been quite 33 per cent. The process of manufacture is hand labour, assisted by steam power for polishing and turning in lathes.

About 10 per cent. of women are employed in making fire-irons, principally "colouring," or passing through their hands whilst turning in the lathe; thus they are coloured or finished by hand-polish.

It is estimated that 10 per cent. of boys are employed, and that the whole number of hands are 500 pairs in this town and district; 25 per cent. are exported.

The French Treaty will no doubt ultimately prove very beneficial to this branch of industry, there having already been considerable exportations to France. Before the treaty fire-irons were a prohibitory article into France.

Fire-irons are also made in Birmingham and Wolverhampton.

The earnings of a good workman are 35*s.* per week; but the average of workmen about 24*s.* per week. Women and boys average about 7*s.* per week.

CAST IRON HOLLOW-WARE, TINNED AND ENAMELLED, AND CAST IRONMONGERY.

BY WILLIAM KENRICK.

UNDER the heading of this paper it is intended to comprise all articles of importance manufactured by the firms engaged in what is commonly known as the hollow-ware trade.

The entire process by which tinned hollow-ware is manufactured was patented by one Jonathan Taylor (said to have been a workman at the Eagle Foundry, Birmingham,) in November, 1779. Taylor's claim, extracted from the specification of his patent, is for "An invention of casting oval-bellied cast iron pots, and 'nealing, turning, tinning, and finishing the same, and also 'nealing, turning, tinning, and finishing such kinds of round cast iron pots and saucepans as are made with a head or rim round the top." Taylor's patent was bought and worked by Messrs. Izon and Whitehurst, who were engaged in the manufacture of cast ironmongery at a small foundry in Duke Street, Birmingham. Whether this firm had attempted the manufacture of black (unfinished) hollow-ware, or of the improved tinned hollow-ware, before their purchase of Taylor's patent is not certainly known; that they made articles of cast ironmongery—now distinguished by the trade name of odd-work—at that time, is inferred from the fact that the firm has always combined the manufacture of these articles with that of *tinned* and *black* hollow-ware since the introduction of the latter, and were also patentees of an invention for making cast hinges, with the secret joint, in 1775. It will be well to explain, in passing, that this invention for casting hinges was for joining the two halves or flaps of the hinge in the casting, instead of casting them separately and fitting them together afterwards. The wire running through the two halves of the joint is surrounded by the cast metal, and is entirely hidden; hence the name of secret hinges.

The advantages the improved tinned kitchen furniture, as it was called, possessed were, that it could be made in any shape required, was light and convenient in use, was elegant in appearance—at least, compared with the three-leg pot which it superseded to a great extent—and was much cheaper than brass or copper cooking vessels. As a consequence, it met with ready sale, and Messrs. Izon and Co. found it necessary to quit their confined premises in Duke Street, and remove their business to West Bromwich, where, in addition to a convenient site for the works, they had the use of water power. This removal took place at Michaelmas, in the year 1780. The traditions of this firm describe the humble beginning of what has since become a manufacture of some importance. It is related that, at Duke Street, the blast for the cupola in melting the iron was got from a bellows worked by two men, and that the machinery was turned by horse power. Also that when Mr. Izon removed to West Bromwich, he brought only seven or eight workmen with him, and that even this small band was looked upon with such distrust by the inhabitants of that then rural district as to be refused lodging, so that Mr. Izon had to buy or build cottages for his workmen. Numerous anecdotes are current in the trade, all of which point to the fact of this manufacture having been begun and conducted on the most primitive scale by those who were the first to engage in it. It may be stated, on trustworthy authority, that iron for making hollow-ware was melted in a pot furnace by a competitor of Messrs. Izon and Co. about the year 1800.

The history of each one of the firms now established in the trade can hardly be thought of sufficient public interest to justify its introduction here. It will be enough to confine our attention to such of them as have the credit of carrying out improvements in the processes of manufacture.

The first improvement to be mentioned is one in the annealing, a process necessary to soften the cast iron before it can be turned bright in a lathe, preparatory to tinning. The method first practised was very rude and ineffectual. The ware was packed in strong iron pots or pans, was piled up in the open air on a stage constructed of strong iron gratings placed side by side and end to end to any required extent. The whole was then covered over with coke, and the interstices, as well within the pans as without, were filled up with coal dust, to prevent as much as possible the access of air to the heated ware. The coke was then fired, and the pile kept at a red heat for about twenty-four hours. The absence of means for retaining and regulating the heat employed—in short, of conducting the operation safely and economically—is here evident. Mr. Archibald Kenrick, who began to make articles of cast ironmongery at West Bromwich in 1791, and hollow-ware in 1805, was the first to remedy these defects, by building an annealing oven. The annealing oven, as it was first constructed and afterwards improved at Mr. Kenrick's works, is an arched chamber, lined with bricks of Stourbridge fire-clay, 22 feet long, 11 feet 6 inches wide, and 7 feet 6 inches high; it has a fire-place in the middle, 5 feet wide, extending the whole length of the oven; it has flues in the walls and roof opening into the oven, and communicating with a stack high enough to cause a strong draught, which is moderated as required by means of dampers. Thick iron pans to hold the ware, 3 feet 8 inches high, and 2 feet 4 inches in diameter, are placed on each side of the fire-place, the flame and hot air from which envelope them completely in passing to the flues. Formerly, when the ware was sufficiently softened, the fire was allowed to burn out, and the oven gradually to cool. There were two drawbacks to the perfect success of this method, viz., the time occupied and the waste of heat consequent on lowering the temperature of the oven to a point at which a workman could enter it, and empty the pans. Both these defects were removed by the simple contrivance of placing the pans containing the ware on carriages, and running these in and out of the oven, on an iron tramway. This last improvement, it is only justice to state, was the invention of an ingenious bricklayer, named Moses Calloway. It dates from about 1817; the brick oven from 1807.

Mr. Kenrick improved the appearance of tinned hollow-ware by attention to the finish, and by substituting a stove-dried varnish for the black lead which had before been used as an outside coating. He also was the first to make saucepans with a rim or head round the top, an improvement claimed in Taylor's specification, but which had never been carried out—probably on account of additional difficulty in casting. Lastly, Mr. Kenrick's improvement in cast iron coffee mills, patented in 1815, gained for him the first name and the largest trade in this article which has since always been associated with the manufacture of hollow-ware.

Of the methods of casting or moulding hollow-ware nothing need be said here, as the principle of all moulding is the same. It will, indeed, surprise anyone skilled in the art as at present practised to learn, what is the fact, that formerly the spouts of kettles were cast separately from the bodies into which they were afterwards fitted.

The lathes used for turning hollow-ware are the ordinary round and oval lathes, the turning tool being held and directed by the workman. Though more than one trial has been made to introduce a self-acting lathe for the purpose, the attempt has been abandoned on its appearing that no saving in cost could be made by the exchange of the simple lathe for the more complicated machine.

The next important invention to be noticed in the manufacture of hollow-ware carries us to the year 1839, when Messrs. Thomas and Charles Clark, of Wolverhampton, took out a patent for enamelling cast iron. Their patent, it is true, was not the first taken out with this object. In the year 1799, a Mr. Hickling invented and patented a process for "improving and beautifying vessels of cast iron, or other metals used for culinary, chemical, and other purposes, by lining them with vitreous compounds." In conjunction with Mr. Francis, then proprietor of the Eagle Foundry, Birmingham, Hickling established a manufactory for the purpose of carrying out his patent, and for some time sold culinary vessels of cast iron, coated with his vitreous compound, under the description of enamelled hollow-ware; but owing to a disagreement between himself and Mr. Francis the manufacture was ultimately abandoned.

Hickling's enamel contained a large proportion of the oxides of lead and tin.

The invention patented by the Messrs. Clark differed from Hickling's advantageously in at least two particulars. Their enamel was free from metallic oxides, or other deleterious substances, and it was applied to the iron in two coatings, the first of which formed the body of the enamel and the second the glaze. The advantage of the first peculiarity of their enamel as a lining for cooking vessels is self-evident; to the second is to be attributed the superior durability of this over other enamels when applied to iron surfaces. Though Messrs. Clark could not claim to be the first, either in this country or the continent, to enamel cast iron, yet there is no doubt that their process is the best for the purpose which has yet been discovered, and as their enamel has now stood the test of a long trial without losing ground in public favour it may be held to be an invention of established usefulness.

Theoretically it must be pronounced impossible, permanently to unite by adhesion two substances such as glass and iron, differing in the ratio of their expansibility by heat; and to have overcome this difficulty, so far as to secure a practical advantage, entitles the inventors to no low degree of praise.

There are two firms manufacturing enamelled cast iron hollow-ware, Messrs. Thomas and Charles Clark, of Wolverhampton, and Messrs. A. Kenrick and Sons, of West Bromwich.

The processes used in the manufacture of hollow-ware are essentially the same as those practised fifty years ago, but the result of these fifty years of competition has been an advantage of 60 per cent. to the consumer, partly represented by an increase in the size of the article sold, and partly by its reduced price. The saving in the cost of production which the manufacture has effected in the same time is due to cheaper material, better tools, and more skilful workmanship. An instance of saving in material is to be found in the one most important to this manufacture—iron. Formerly the Madeley Wood Company's iron was the only brand thought suitable for making hollow-ware. The price of this iron in 1814-16 ranged between £8 15*s.* and £9 5*s.* per ton. Iron used in making hollow-ware is now bought at prices between one-half and one-third of the above.

It is a peculiarity of the chief houses in the hollow-ware trade that they also make a great variety of articles of general ironmongery, such as hinges, pulleys, coffee mills, smoothing irons, umbrella stands, door knockers, latches, handles, scrapers, porters, &c., and a great variety of miscellaneous articles included in the trade term of "odd-work." The manufacture of some of these articles was in every instance the original business, to which that of making hollow-ware was added, but the number of branches of manufacture has usually gone on increasing with the age and standing of the firm.

Black or untinned hollow-ware, such as rice bowls, three-leg pots, Dutch stoves, &c., is still made in the district, but the greater part of this once important trade has left Staffordshire, Worcestershire, and Shropshire for Scotland.

The manufacture of cast iron nails and shoe pins is peculiar to this district, though, curiously, the demand for one description, called lath nails, is almost entirely for Scotland. The smallest nail made is ¼-inch in length, and of these a good workman will mould upwards of 750,000 in a day; the largest measures 2⅛-inches long, and of these a good day's work is about 52,000. The yearly production of cast nails is about 1,000 tons.

There are few civilised countries which do not import English hollow-ware, but the best foreign markets are, as a rule, found in the British colonies. Little or none is taken by France, and since the outbreak of the civil war in America the same may be said of the United States.

There are fourteen firms, small and large, occupied in the manufactures noticed in this paper. Of these eight make tinned and two enamelled hollow-ware, the rest black hollow-ware, cast nails, and odd-work only. The aggregate of hands employed, as nearly as it has been possible to ascertain it, is 2,430. Of this number 1,370 are men—mostly skilled workmen, 900 are boys, and 160 women and girls. The yearly consumption of pig iron is estimated at 12,000 tons, of coal and coke 23,000 tons, of wrought iron 1,000 tons, and of refined tin 177 tons.

Besides the eight manufactories of tinned hollow-ware already mentioned, there are in the United Kingdom two more, one established at Liverpool, the other at Glasgow.

The condition of labour in the hollow-ware and associated trades is favourable to the workman; employment, at least in well established businesses, is regular and well paid; the kind of work though often severe is not injurious, and workshops are mostly large and not overcrowded.

The proportion of boys to men employed will be seen from the above return to be large, while that of women and girls is not very considerable. About one-third of the whole number of boys may be taken as between the ages of nine and thirteen, and consequently liable to be subjected to the half-time provisions of the Factory Acts, should factory legislation be extended to this district. Difference of opinion exists among employers as to the benefit or injury to be expected from an application of the half-time system in foundries. It is feared by some that the youths forbidden to work more than half the day, or on alternate days, would be thrown out of work altogether; while others contend that such will not necessarily be the result, since the demand for juvenile labour would continue what it is, while the supply would be lessened.

It is a less disputable conclusion that, unless some limit of the kind proposed be fixed to the employment of children in factories, the standard of education in the artisan class can never be raised to a respectable level.

Women and girls are employed to varnish and paint, to sort and wrap up goods, and a few to make small sand cores used in moulding. In two small foundries only they take the place of boys as casters' assistants. Instances of women working as casters are still remembered in the trade; this practice, always exceptional, has, happily, been discontinued.

The wages of skilled labour average from 25*s*. to 40*s*. a week. It may be taken as an evidence of provident habits in this class of workmen under favourable circumstances that, of the number employed by one firm, one-fifth are freeholders.

THE HAND-MADE NAIL TRADE.

BY EPHRAIM BALL.

THE manufacture of hand-made nails dates back from an early period. It is one of the oldest trades in the midland counties, and has been, and is, one of considerable importance. It is stated, in a work entitled the "Universal British Traveller," published some time towards the end of the last century, that the town of Dudley is large and populous, and the people are chiefly employed in making nails; also in the same work, "that the town of Halesowen is well inhabited, and that the principal manufacture of the town consists in making nails. Before the year 1800, nailmasters held meetings at Dudley to regulate workmen's wages, &c., which meetings, with few exceptions, have been regularly continued up to the present time.

The nailmakers, or nailforgers, are what may be termed out-workers; or, in other words, the manufacture of hand-made nails is carried on at the workmen's own homes, where they have a small workshop, which is termed a nail shop. A few years ago, a nail shop was frequently attached to small farmhouses, in which the farmer and his family made nails when they could not work on the farm.

The districts in Staffordshire and Worcestershire in which the manufacture of hand-made nails has been carried on in the present century are extensive, comprising—Dudley, Sedgley, Gornal, Coseley, Womborne, Wordsley, Rowley, Netherton, Cradley, Lye Waste, Oldswinford, Stourbridge, Halesowen, Bromsgrove, Northfield, Harborne, Birmingham, Tipton, Oldbury, Darlaston, Pelsall, Burntwood, West Bromwich. Hand-made nails are also made at other places in England and Scotland.

When a nailmaster commences business, he opens a warehouse in one of the above-named districts; but, to carry on a large trade in all descriptions of hammered nails, he must have supplementary warehouses in several districts. At each of these warehouses, on certain days in the week, nail-rod iron is delivered to the nailmaker sufficient for him and his family to work up in a week, and at the expiration of that time he is expected to return the iron made into nails, when he receives a further supply. A nailmaker, his wife, and all his children above the age of nine years, are generally engaged in his small nail shop making nails; children, both boys and girls, are generally put to work in making nails at the early age of nine years.

The length, thickness, shape, &c., of hand-made nails are very numerous, and in nearly every district a different class of nails is manufactured; for instance, those made in the districts around Dudley are not made in the neighbourhood of Bromsgrove.

The fluctuations in the price of ordinary nail-rod iron, from which hand-made nails are manufactured, have been considerable in the present century—the highest price was £21 per ton, the lowest price £4. 17*s.* 6*d.* Such prices of iron do not refer to the price of best, or charcoal horse-nail-rod iron.

The hammered nail trade for some years has been declining from several causes. About the year 1830, it was computed that in the districts before named there were employed in the manufacture of hand-made nails about 50,000; at the present time not more than 20,000 are so employed. Before 1830, there were from forty to fifty firms largely engaged in this important trade. The nailmaker at that time received fair wages, had full work, and was generally paid in cash. It may safely be considered that about 1830 this trade began to decline, owing to the introduction of machine-made nails. All the great dock contracts for nails up to and about that time were hand-made, whereas now the greatest part are machine-made.

The East India Dock Company before 1830 contracted annually for about 110 tons of hand-made nails, about 90 tons of which were tea-chest nails; but, at the present time, only a small quantity of hand-made nails are required by this Company.

The London Dock Company now contract annually for about 50 tons of machine-made tea-chest nails, and only about 17 tons of hand-made nails.

Previous to the introduction of machine-made nails the demand for hand-made tea-chest nails was large, and the nailmaker was well paid. The reduction on wages for hand-made tea-chest nails now amounts to about thirty-five per cent., and, with this immense reduction of wages, one inch machine-made nails can be produced and sold at about one-fifth of the price of hand-made nails.

The Government contracts for hand-made nails were of great importance to the nail trade, which contracts, like others, are declining in favour of machine-made nails. The system also in tendering for the contracts at the present time is bad, in proof of which only three firms in the nail trade sent in tenders for the last Admiralty contract. These contracts frequently come to the trade second-hand, and workmen do not derive the benefit from such work as they should do. In 1820 the quantity of hand-made nails required by the Admiralty was about 640 tons in the year, at the present time the quantity is very much reduced and comparatively small.

The United States and Canada used to be large buyers of hand-made nails, but very few are now sent out.

The Australian trade for hand-made nails is largely supplanted by "Ewbank's" patent nails, which nails also compete with the hand-made nail in our home trade; they are called wrought, but are made by machinery. The demand for these nails is considerable.

The introduction of machine-made nails was serious to the hand-made nail trade; but the English nailmasters have had other competitions and difficulties. In 1837, at a meeting of nailmasters, a resolution was passed:—

> "That, in consequence of the unusual depression in the nail trade, and the introduction of foreign-made nails into the market, a reduction in workmen's wages has become absolutely necessary."

The foreign-made nails were made in Belgium, and the low prices at which they were offered could not be believed at the time; and to this day the English nail workman will not believe that the English nailmaster has such competition. Generally, however, the nails are inferior to the English make.

In 1851, it was estimated that the manufacture of Belgian hand-made nails was about eight to nine thousand tons per annum, since which time the make has increased.

In 1838, a further reduction took place in nail workmen's wages. A resolution of the masters was—

> "That this meeting makes this reduction with reluctance, but is compelled to do so in consequence of several houses having reduced the workman's wages some time past; and this meeting will be compelled, in self-defence, to follow those houses who attempt clandestinely to bring down wages."

On the 6th April, 1842, at a meeting of nailmasters, the following resolution was passed :—

> "That, although this meeting is informed that some masters have been reducing wages for some time past, it is the opinion of this meeting that wages, as already fixed by the masters, are low enough, and they entreat those masters to give the full amount of wages, thereby preventing that distress which must otherwise follow such practices."

Eleven firms represented this meeting personally, and it was resolved that two gentlemen be appointed to wait upon the masters not present at the above meeting, to solicit their sanction to the resolution, and the meeting was adjourned to the 19th April.

On the 19th April, the masters held another meeting, and a list of workman's reduced wages was adopted—such reduced scale of wages to come into operation on Monday, the 25th April, 1842. On the morning of the 25th April, to the surprise of the whole district, and also unexpected by the masters, a meeting of fifteen to twenty thousand men took place. They went to several warehouses, taking out by force the principals, and marching them on foot a distance of three miles, to the town of Dudley; on arriving at Dudley they endeavoured to get the Dudley masters into their hands, but did not succeed for some hours. Those masters in their hands were at their mercy; at length the military arrived from Birmingham, the Riot Act was read, the masters released, and the mob driven out of the town. On the 28th April another meeting of fifteen firms of nailmasters was held, which resulted in withdrawing the list of wages made on the 19th, and adopting the list of 1838, subject to ten per cent. discount; at which meeting they pledged themselves to use every effort to put down the truck system, and to employ all workmen who should lay information against masters paying in truck, or who should be discharged for refusing to take their wages in truck.

The nail workmen in Dudley at this time were in a very excited and violent state, many masters were much afraid for the safety of their property and even of themselves. It is a fact worthy of notice that the men grossly illtreated some of the best "money" paying masters in the trade; for this treatment the nail workmen paid a heavy penalty; the trade was left to take its course, no meeting of masters to regulate wages took place for some time, and gradually reductions in wages were made, during two years, from twenty to thirty per cent.

The large and wealthy "money" paying firms are reduced in number, capital has been withdrawn from the trade, and a different class of employers of labour has, to a great extent, taken place. Since 1842, the hammered nail trade has been subject to many numerous strikes, in fact, no other trade has suffered by so many. It has become a household word to say, "What? another nailors' strike." The secret of all such strikes arises from whole districts in which hand-made nails are manufactured having suffered from a truck system of an oppressive and vicious character, which is the great injury of fair trading, and especially injurious to the workmen.

There are at present only a few firms in the trade who will put any large quantity of nails into stock, consequently, the moment the trade shows any signs of flatness, some masters endeavour to obtain a reduction in wages, which very soon becomes general throughout the trade, resulting in strikes.

The nail workmen at the present time are in a most deplorable condition; during many years several nailmasters have endeavoured to put down the truck system. The late Theodore Price, in 1833, addressed the trade as follows:—

> "Let us consider the powerful operation of this system, first as it regards the comfort and happiness of 50,000 nail forgers; to them, compared with the trade list prices, it is as payment with base coin; and the truckster thus paying, brings down the unwilling money-paying master in order that he may meet him, though with distressing odds, in the market; then it is that wages are step by step brought down so low as just to enable the workman to keep body and soul together; lower than this the most steel-hearted and brazen-faced do not venture to go."

Mr. Price was largely engaged in the manufacture of hand-made nails. The truck system, at the time Mr. Price wrote the foregoing, was only in its infancy; now, the result is, numerous workmen prefer to sell their nails at the truck shop every day, and in many instances every meal. It is a well-known fact that, at present, more than one-half of the hand-made nails are paid for in "truck," but such nails are of very inferior quality, thereby injuring the *prestige* of the English hand-made nails in foreign markets. At the best of times the average weekly earnings of a nailmaker are not more than 12*s*. to 16*s*. per week, and there are many workmen who cannot earn more than 10*s*. per week; the women earn upon an average about 6*s*. to 8*s*. per week, and the children about 3*s*. to 5*s*. In consequence of the nailworkmen being out-workers, the masters cannot exercise that control over them which they can in most other trades.*

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* This constitutes the chief difficulty in introducing any sort of Factory Act for the protection of the workpeople in the Midland Hardware Districts. However desirable such supervision would be, it is practically impossible, as involving domiciliary visits to an enormous extent.—EDITOR.

There is yet vitality enough to make this trade one of much more importance in the before-mentioned localities than at present. It is to be regretted that a hard-working population amounting to about twenty thousand are badly fed, badly clothed, and degraded by a system which is a disgrace to England. Those hard-working people are confined to their small unhealthy nail shops, manufacturing an article unequalled by any country in the world for excellence and variety of workmanship. It is believed there will always be a large demand for hand-made nails, and every reason to think that if the truck system could be abolished the superior quality of the English hand-made nails would regain, to a great extent, many markets which are now supplied with the so-called cheap Belgian nails.

We now come to the manufacture of hand-made horse and mule shoe nails, an important but different branch of the same trade, employing about two thousand workmen in the districts around Dudley. This trade for some years past has been subject to the outbreaking of strikes. The causes of such strikes have been totally different from strikes in the other hand-made nail trades before alluded to. This part of the trade may be said to be distinct from that of the general hand-made nails; at present this portion of the trade is not fettered to any great extent with the truck system, and in all the districts there is about only one single instance of females making horse nails. Previous to 1850, numerous attempts were made to produce horse-nails made by machinery, all of which failed.* The men were aware of this, and established a trade union; they had an impression that eventually they could obtain very large wages, and made very arbitrary laws, making demands of the most extraordinary nature upon their employers. In 1860, they gave one of the masters notice for an advance of wages, merely on account of his having violated their rules, by employing a workman in the manufacture of a certain kind of horse nail on an improved principle. A meeting of the masters was called, the men were requested to withdraw such notice, or a lock-out of the whole trade should take place. The men accepted the lock-out, and nearly the whole of them remained on strike about twenty weeks, during which time nothing could induce them to return to work; they were bent upon carrying out their principles. The masters, on the other hand, knew that unless they resisted the trade would be annihilated. During this strike some very diabolical acts were committed; peaceable men who would could not follow their employment, fearing their workshops might be blown up or entered in the night and their bellows cut to pieces. A change has now taken place, and it is to be hoped the men have seen their folly; the union also is disorganised and broken up.

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* Machine-made nails are usually cut out of flat sheets of iron, and, however good the quality of this may be, it never produces nails which are so firm in texture and so ductile as those which are hammered out of—"drawn down"—an ordinary nail-rod, by hand. It is a curious fact that horse-shoe nails require a first-class quality of iron, and this, when well worked by hand, is so far improved in quality as to be preferred for the manufacture of gun barrels.—EDITOR.

From 1810 to 1840, the rate of wages, with few exceptions, for making a pound of 2-inch horse nails was 3¼d.; in 1842 and 1843 it was reduced to 2¾d. per lb.; but in 1864 the rate of wages advanced to 5⅛d. per lb.

The advances obtained on wages from 1850 to 1864 averaged 50 per cent., and about 60 per cent. on the rate paid in 1843.

Such high prices were sure to bring about a depression of the trade which yet exists, and, in consequence, the horse-nail workmen during some time have not had half work, their wages also declining. The average earnings of a first-rate horse-nail maker at the present reduced prices, for a full week's work, is from 22*s.* to 25*s.* per week. If the men will be content with such wages and listen to the advice of the large employers, there is every reason to believe that the English hand-made horse-nails will be preferred to any machine or hand-made nails produced in any part of the world.

Some of the large houses in the hammered nail trade manufacture horse shoes, mule shoes, chains of every description, &c., &c.

At Halesowen there is a manufactory for making "patent" mule and horse shoes, suitable for the South American trade, which shoes are produced by rolling iron, by hand labour, and by machinery.

In several districts around Dudley, Halesowen, Cradley, &c., a large number of men, women, and children are engaged in the manufacture of chains of every description; large quantities of cheap American traces, &c., are made by women and children at very low wages, hence of inferior quality. Also large quantities of other chains of a very inferior quality have been manufactured, which the new Act of Parliament relating to chain cables will no doubt remedy, and a more healthy trade be established for first-class goods.

WOLVERHAMPTON TRADES.

By HENRY LOVERIDGE.

Tin-plate working and japanning might be called one of the staple trades of South Staffordshire, as the two are generally carried on together, depending on each other to a very great extent for mutual support; but in speaking of them here it will be necessary to treat them distinctly, as they do in some instances exist independently of each other.

At a very remote period there would no doubt exist some kind of tin-plate working, which would be nearly akin to the business of the armourer—when those rude but very durable bowls were made and tinned, which we occasionally see in collections of antiquarians, or in the museums of the oldest towns either here or on the continent. But of the exact date at which such an industry assumed a form and importance, either in this part or any other part of England, we have no knowledge. It appears that the manufacture of tin-plates was introduced from the continent in 1665, by Andrew Yarranton, who established a works or manufactory in the Forest of Dean. The great utility of tin-plate, for the uses to which it is now so extensively applied, became no doubt immediately obvious to some at least of those connected with the neighbourhood, for we find that the first tinware made and japanned in this country spoken of, is that of Pontypool, in the neighbouring county, a place which long held a name for the excellence of its tin japanned wares, as well as for the durability of its varnishes. The tin-plate workers' business had, about the middle of the last century, assumed some little importance in Staffordshire; dying out gradually in Monmouthshire, we may assume that it fixed on Wolverhampton for its head quarters, whilst the neighbouring town of Bilston, then a mere hamlet, appears to have been the seat of makers for the lighter and cheaper description of small tinwares, and common japanned tea trays and waiters; of the latter, such goods as were, and still are, required by our older colonies, South America, and other countries, in which a lack of wealth and education combine with specific instead of *ad valorem* duties to encourage an importation of the lightest and commonest goods of an ornamental character; but the chief manufactories were and are still to be found in Wolverhampton. The two trades have, since 1849, in this locality, doubled in extent; this increase is doubtless, as in that of the neighbouring town of Birmingham, partly attributable to the increase of our population, and the extension of our commerce, resulting, as we believe, from the blessings of free trade, and partly from the great variety of novelties for household purposes, which have been introduced by the tin-plate worker—the name of these things is legion—and is daily increasing, and will, of course, continue as long as the inventive faculty lasts. So long as one man fancies he can contrive an improvement in coffee pots, or a new way in which to get the greatest quantity of pudding out of the smallest-sized pan, so long must it go on.

The efforts to improve the forms and style of some of our domestic wares by means of the modeller and stamper were, in the first instance, attended with great losses from the lack of experience in treating iron and tinned-plate sheets. One cause was no doubt the faulty nature of the iron, which, if not thoroughly sound in its substance, is sure when rolled to produce sheets which will throw up a faulty surface. But by degrees these processes have been so improved that the stamper is now enabled to produce those beautiful forms with sheet iron which formerly could be obtained from the more ductile metals only. Through a wide range of varieties, from the humble patty pan upwards, we get dish covers and stamped articles up to 3 feet diameter, so that the bath-room may now be well furnished with baths, jugs, and basins of a most durable character, which defy the carelessness of the chambermaid, and are indispensable to the emigrant. The same processes have increased marvellously the variety of things for japanning, such as trays and waiters of improved forms, novelties in coal vases, the names of which are numberless; now we have, in addition to coal vases, "Purdonians," "Ruskins," "Russel's," "Persians," &c., &c., without end, some of which possess great merit, both for their novelty and utility—these things having been effected, as we have said, by the partial aid of machinery, in addition to the continued use of the old indispensables, the mallet, hammer, stake, and other tools of the trade. To pursue this part of our subject further would be superfluous, unless, indeed, we went into details of manufacture, which is scarcely the object sought for.

We now turn to the sister business, that of japanning. We are not so fortunate here as with the tin-plate worker's business. We appear to have no starting point which we can fix on as the commencement of the business in this country; doubtless it claims a higher antiquity than that of the former business we have been speaking of. Originally, as doubtless all readers are aware, the art of covering substances with japan, or lacquer as it has been frequently called, and afterwards decorating them, was first shown us by the Chinese and Japanese nations, but was, as we are obliged to infer, first practised here as a business at Pontypool and the neighbourhood. The things chiefly made there having been tea trays, waiters, candlesticks, and small boxes; but since its introduction into Staffordshire the art has expanded in a surprising manner, having become united with the tin-plate trade, one of the important industries of the locality. The thousands of articles now made are of commercial value from the protection or decoration, or both, imparted to them by the japanner. When it is borne in mind how thoroughly efficient for economical purposes is a good coating of japan on any iron or tin-plate surface, we need not be surprised at the universality of its application. Metal surfaces, as we all know, of all kinds, even gold itself, give off a kind of oleaginous substance which soils the fingers by touch. Silver and tin do the same in a greater degree, and iron articles by exposure produce an oxide which would render them useless unless protected by tinning or japanning; and as japanned surfaces are so readily cleaned, and fitted thereby for domestic use, we need not be surprised that they commend themselves so generally to the housekeeper and economist as most suitable for common use.

The application of the japanner's art received an impetus when Clay, in 1773, secured a patent for, amongst other things, the manufacture in papier maché of roofs of coaches, sedan chairs, doors for rooms, panels, cabins of ships, tea trays, and waiters. The two last named articles are the chief survivors of the things enumerated in his specification as holding a commercial value. The invention, however, was very important as touching the japanner's art, for the great utility of these things being obvious, the demand soon became extensive both for those and the iron trays previously in existence, and this, of course, extended the field of labour for the japanner in which to practise his art, in the pursuit of which some of the men engaged in it became really artists, and the trade has given to the list of professional artists the name of Bird, the Royal Academician, who practised the art of painting in japan upon trays, snuff boxes, and other things, in Bristol, perhaps Birmingham, and certainly in Wolverhampton. Others have followed in the same track, and obeyed the impulses which the practice of such an art is calculated to impart. In the present day the name of Underhill stands conspicuous as one likely at no distant period to become equally famous with that of Bird.

Notwithstanding these glorious exceptions, however, we doubt if any great progress has been made in the trade in the artistic direction; the men lack education in drawing and colour to such an extent as to prevent great progress. It is true that the feeling, so to speak, arising from the general spread of education—the unfelt influence thereof, and the consequent improvement in the taste of the public at large—has operated to eradicate some of the monstrosities which were produced, and which found favour, to some extent, with purchasers. We no longer see—to quote from one of our distinguished men of the day—"Abraham in red sacrificing Isaac in blue upon a green altar with a black ground." All that has been changed with the customers for superior goods, and a demand has of late existed for goods of an opposite character. Colour, nature, or any imitation of her, however good, has for some time past been ignored, and superseded by a taste for the most colourless things, "gold colour" excepted. The hue of the metal which subdues the world has been the only popular one in the ornamentation of tea trays and waiters. However, we have been told by one whose name in matters of art is just now much before the public, that "colours are coming in again," that the flat and insipid will soon give place to Tyrian dyes, and hues that emulate the rose, so that we shall again have a chance of encouraging our ornamentors who can paint flowers and use colours judiciously. By the time this is the case, let us hope they will be prepared for their work with more intelligence than ever.

The men engaged in the two occupations have, as might have been expected, improved much in their social and moral conditions. Aided by efforts to some extent on the part of the employers, we find much for congratulation. Within the last twenty years a marked improvement has taken place, and many of the men who were most intemperate have become sober. The public-house is less frequented than formerly.

Sobriety has brought in her train economy and propriety; order reigns where brawls were frequent; and at the election for county members we find a goodly number of the better men of each trade, who have not only the privilege of a vote, but who know how to use it with intelligence.

These are indications of an unmistakable character, as amongst the artisan population of this country we think intelligence is generally found associated with material prosperity. Amongst the japanners a little more special education is desirable; for a man to excel in his art, he should know something of perspective, and more of colour. The great and invaluable benefits to be obtained from a School of Practical Art are not yet thoroughly understood in this locality, or we should most certainly see more of the artisan children there, where for so trifling a fee sound knowledge may be obtained from thoroughly qualified teachers; but the lack of knowledge is not felt by many of the men, and their children, of course, lose the advantages which are so nearly at hand. In this district there are, with their families, about 10,000 persons dependent on these two industries.

At Bilston, where the commoner kind of japanned goods are still made, about 400 persons are employed, of whom 300 are women and girls.

[In addition to the above report the following statistics have been contributed by Mr. J. E. Tildesley, who has devoted much attention to the history of the Staffordshire trades :]

The number of separate factories in this district in which the manufacture of tinware, japanned goods, and kindred articles is carried on is twenty-four, of which ten are situated at Bilston, and fourteen at Wolverhampton.

The approximate number of workpeople employed is 2,000, 400 of whom belong to Bilston. The proportion of females engaged in this industry is about sixty per cent. The males, comprising youths and adults, are employed as tin-plate workers, pressers, tinners, assistants, underworkers, and painters.

The females work at japanning, painting, and polishing.

Her Majesty's Inspector of Schools for this district complains, that the young people employed at the japan works of Wolverhampton and Bilston work so late in the evening that they cannot attend evening schools during the latter part of the week. Of the number of girls from the japan factories who do attend these schools, one-third are unable to read or write.

In Wolverhampton, there is a large establishment for the manufacture of tin toys, the only factory of the kind in the district.

The leading articles in the japanning trade comprise trays, waiters, coal vases, and tea caddies.

Trays are made of iron, varying in thickness from 24 to 30 gauge, chiefly made in the district. The prevailing shapes of these articles are gothic, convex, and oval. Trays vary in size from 12 to 30 inches, and waiters from 6 to 20 inches. The price of trays is from 8*s.* 6*d.* per dozen, and waiters from 1*s.* per dozen and upwards. The very cheapest are simply japanned, but better qualities are decorated. The variety of trays as regards decoration is enormous, each maker of importance having some 2,000 distinct patterns.

The cheaper descriptions, made for the most part at Bilston, are largely exported to South America, Spain, Russia, and Norway, decorated to suit the various tastes of the purchasers. For South America, gaudy colours are appreciated, as also in Norway and Russia. For Spain, the representation of a bird is the favourite ornament, while Brazil orders a wreath of coffee berries, surrounding a shield. The better class of articles however, such as are principally made at Wolverhampton, are chastely decorated with floral groups, neat gold borders, and other artistic embellishments. These are in demand for home trade, as well as for the United States, the Colonies, India, and France.

Trays are sold in sets, three forming a set, and the aggregate weekly make is upwards of 2,000 sets. Waiters are made in much greater quantities, the weekly production being not less than 50,000.

Coal vases are made in great quantities both at Bilston and Wolverhampton.

Tea caddies are perhaps more extensively made at Bilston, the aggregate production of that town exceeding 2,000 per week.

Tin-plate working includes, in its prominent articles of manufacture, baths, toiletware, jugs, cups, coffee pots, &c.

Baths of all kinds, foot, hip, shower, and sponge, are made in great numbers for the colonies. They are usually sold with what is termed a toilet set, consisting of both water can and slop pails, the price of a set varying from 9*s*. to 18*s*., according to quality.

Bowls, cups, and jugs of tin, brilliantly painted, are made extensively for the Scotch market, bearing the names of Duncan, Bruce, and other heroes of the "Land o'Cakes." South America is also a large customer for bowls.

The rate of wages averages 30*s*. per week for skilled workmen, both in the manufacturing and painting departments. A skilled artist can paint with ease two gross of small landscapes per day. The japanners earn about £1 per week. Women's wages average 8*s*., and girls' 3*s*. 6*d*. per week.

The rate of wages is rather higher in Wolverhampton than in Bilston, owing to the better quality of the work produced, and the superior skill of the workpeople.

There are also six galvanizing works in Wolverhampton and Bilston, employing 400 males.

Extracts from Government Report (1864).

The tin-plate and japan works in Wolverhampton are large, employing severally from 250 to 300 hands, of whom fifty to sixty would be young persons, male and female. In the three largest factories of this class, no children are regularly employed, except one or two little boys or girls to run errands, and wait on the men and women. In the smaller factories at Bilston, where the cheapest goods are manufactured, there are about fifty children altogether employed in the painting shops, of about ten to thirteen years of age, chiefly girls.

Youths of all ages are employed under the tin-plate workers, and at pressing blank trays, &c. Four or five boys are employed by each tinner in the larger works. In the painting shops, young persons, male and female, are employed with adults. Women and girls do the japanning, varnishing, and polishing.

The employments incident to the tin-plate and japan trade comprise two departments—the manufacturing department, and the japanning and finishing department. The former department comprises working the tin plates, stamping, tinning, spinning, wheeling, and enamelling.

Most of the factories of this class, both in Wolverhampton and Bilston, are well built, and the rooms properly ventilated. As a rule the shops are not over crowded.

In the larger tin-plate and japan factories in Wolverhampton, the employers are opposed to all overtime, and it is scarcely ever resorted to. In some of the smaller factories at Bilston, overtime to 9 and even 11 p.m. is occasionally resorted to for one or two nights in the week, but generally speaking the hours of work in this trade are less than in the other trades of the district.

The earnings of the children and young persons in the japan factories at Bilston are very small. Boys and girls from eleven to thirteen years old get 1*s*.6*d*. to 2*s*. per week at painting; girls of fifteen get 3*s*. At Wolverhampton, the girls and women in the painting and varnishing shops earn from 4*s*. to 7*s*. The polishers can make from 10*s*. to 15*s*. per week.

THE WALSALL TRADES.

By WILLIAM FRANKLIN.

(With Addenda, by J. E. TILDESLEY.)

Walsall, a town of upwards of 35,000 inhabitants, eight miles from Birmingham, and six from Wolverhampton, is situate on the outskirts of the great mining district of South Staffordshire, and has for more than 100 years possessed a trade in saddlers' ironmongery and saddlery. Doubtless at a period somewhat antecedent to this, the easy means of procuring iron and steel from the works in the immediate neighbourhood would have an influence in forming the trade of the town, but why it should have assumed this particular form of manufacture it is somewhat difficult to determine, unless we conclude that the present trade is the offspring of the trade in shoe buckles, which appears to have had its rise in the early part of the eighteenth century, and to have become entirely extinct towards the close of it. This view would appear all the more probable as it is but a step from the formation of buckles for shoe purposes to those required for saddlery—indeed from this small beginning we may with tolerable certainty date the commencement of the trade which has made Walsall the second town in the county, and the chief seat of saddlery manufacture in the kingdom. During the first thirty years of the present century gradual progress was made, but, with the exception of some trade with India and America, the demand was confined to the home market. Periods of stagnation were frequent, and whenever a bad harvest occurred, a time of depression inevitably followed. But simultaneously with the finding of gold in Australia a trade was opened with that colony. This trade in its results has been of inestimable value to Walsall, preventing by a continuous demand those periods of inactivity from which it had hitherto suffered, and at the same time, by enquiry for articles only of an enduring quality, stimulating the manufacturer to produce goods of superior make and workmanship; thus, while augmenting the trade, tending to raise also the style and finish in most of the branches of manufacture. With this encouragement the export has been still further cultivated, and a considerable amount of business is done with South America, Canada, New Zealand, and the Cape. With America a much greater trade might be expected if the tariff were lower, but forty per cent. upon saddlery has a most restrictive effect. As yet no market has been opened with China and Japan. Expectations were raised by the treaty with France, but they have not been realised; the French show a disposition to take our raw materials, but manufactured goods only to a very limited extent, and then at prices lower than they can be procured in France.

The staples of the town are principally iron, comprising the manufacture of small castings forming the basis for a variety of articles finished by turning, polishing, or plating with brass or silver. The introduction of malleable[*] iron some years since has enabled the manufacturer to produce castings of a superior kind, such as at one time it was thought impossible to make except by forging. The articles are in great variety. The workmen are not very numerous; earning wages of about 24*s*. per week.

CHAINS, CART GEARING, AND HAMES,

Employing in the forging a considerable number of hands for home and export. The position of workmen not very good, the remuneration being from 16*s*. to 20*s*. per week.

STEEL AND IRON BITS AND STIRRUPS.

The manufacturers are numerous; export to North and South America; probably finding employment for more than 1,000 operatives, forgers earning 28*s*. and finishers 20*s*. per week.[†]

[Formerly bits were all forged, but now many are made of malleable iron, which are cheaper, but not so safe or durable.]

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[*] Here, and throughout this volume, the phrase "malleable iron" is used in a special technical sense. Scientifically, iron may be divided into two classes, "cast" (or brittle), and "wrought" (or malleable); but in the hardware districts generally, malleable iron does not mean ordinary wrought iron, but iron cast in moulds and rendered malleable by a process hereafter to be described under the Birmingham Trades.—EDITOR.

[†] The South American trade has long supplied one of the most important branches of trade in Walsall. The elaborate saddles and horse furniture used in Brazil are chiefly made in Walsall, and much of the furniture in brass—stirrups, &c.—by Birmingham manufacturers. During the last few years, the old-fashioned harness saddle, made chiefly of leather, has been partially superseded, especially in foreign markets, by a "patent saddle" in which the whole is cast in malleable iron and then japanned so as to look like patent leather.—EDITOR.

PLATING IN SILVER AND BRASS,

Chiefly connected with harness furniture, and since the introduction of the electro system, has been brought to great perfection. This branch of trade has increased 100 per cent. since 1849, and employs 1,000 operatives, earning about 21*s.* per week.

LOCKS.

With an export to India and the Levant, doubled since 1849. Hands employed, about 700, earning 21*s.* to 22*s.* per week.

[At Walsall, wrought iron pad locks are made *(see Addenda)*, and at Birchills, chest and cupboard locks, all of the cheaper kinds.]

SPURS AND SPRING BARS.

Number of operatives employed, 300; earnings, from 20*s.* to 25*s.* per week.

GAS TUBES, CHANDELIERS, AND IRON BEDSTEADS.

This branch of trade was introduced about 1830; and although but three works of this kind exist, they are extensive in character, employing over 1,500 pairs of hands. Machinery of the newest and best kind has been applied, superseding considerably hand labour, and making tubes capable of sustaining great pressure from either steam or water; the facilities of supply are great in this trade, and in consequence competition excessive, enhanced by the advanced price of iron and coal, the latter having risen about thirty per cent. within a very few years; the exports are to the continent and the colonies; earnings of operatives employed, from 15*s.* to 30*s.* per week.

[Another large factory has been built since this paper was written.]

SADDLERS' TOOLS, SWIVELS, SPRING HOOKS, CURBS, AWL BLADES, SADDLE TREES,

All more or less connected with the saddlery trades, form a very important part of the manufactures of Walsall; but awl blades are made almost solely at Bloxwich. *(See Addenda.)*

Total number of awl-blade factories in Walsall and Bloxwich, twenty-seven.*

BRASS CASTING AND FINISHING,

Chiefly as connected with harness furniture, the ornamental part of saddlery. Men employed, about 500; earnings, 20*s.* per week.

LEATHER,

For which this town has long been famous, is made by tanning to a considerable extent, and prepared for use by the process of currying to a much greater extent, the tannages of the west and north of England being preferred for this purpose; the leather is mostly adapted for saddlery, but shoe leather is also well represented. The trade in leather has made great advances, the demand being double that of 1849. A noticeable feature may be found in the manufacture of japanned leather, a variety of brilliant colours being given, while black only could be made at that period. The number of men employed in the manufacture of leather, about 300; the earnings of tanners being 18*s.*, and curriers, 28*s.* to 35*s.* per week.

SADDLES.

Produced in large numbers, with exports to Australia, New Zealand, South America, and India, the trade doubled since 1849, and marked improvement manifested in point of quality and finish during the last five years. Women employed in stitching ornamental parts of side saddles, number, 200; earnings, about 7*s.* per week, and saddle hand operatives, 400; earnings, about 25*s.* per week.

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* The manufacture of awl blades—for shoemakers, saddlers, carpenters, and others—at Bloxwich, is one of those localisations of trades for which it is difficult to account. The trade appears to have originated in Sheffield, where the proper steel could be readily obtained, and to have been brought to Staffordshire by some accident when steel could be procured in the neighbourhood; at present, however, Sheffield steel is still used here. Bloxwich has been famous for awl blades for about a century, and still makes the larger part of these articles, the rest being made in London, Sheffield, and Birmingham, but not to any great extent. The production of shoemakers' awls—especially for the United States market—is very large. The "tacks" used by shoemakers are also made here to a very great extent, and latterly of steel instead of iron, and at lower rates than iron tacks were formerly sold. Both awls and tacks were formerly made like nails, at the homes of the workmen; but recently some manufactories have been established, where forgers and filers are employed, and the awls are polished by steam power.—EDITOR.

[It is estimated that more than one-third of the saddles made here are for the colonial market, chiefly Australia and New Zealand. Leading kinds, common riding saddles, shaft saddles, full shafts, and ladies' saddles, in addition to military saddles. The best hunting saddles are made of pig skin.]

HARNESS MAKERS AND BRIDLE CUTTERS,

Trading principally with London, Birmingham, and Wolverhampton; exporting to Australia, North and South America. This branch has also doubled its make since 1849, and in time of war can always be made available to the Government, 25,000 sets of artillery and cavalry harness having been furnished in twenty months, without materially interfering with its home or export trade. Number of workmen employed, 200; earnings, 22*s*. to 24*s*. per week. Women: number, 300; earnings, 7*s*. per week. Perhaps it may be worthy of remark that little inventive genius has been displayed, and few changes of form or appearance made in harness or saddlery since 1849, the exception being the Nolan saddle, invented by Captain Nolan during the Crimean war, and now generally used in the army; it is mainly composed of wood, with solid leather seat, but is only suitable for military purposes.

[The harness trade is divided into several branches. Collar making is quite a distinct trade, as also is saddle making. Those engaged in the latter are called "black saddlers" to distinguish them from the makers of brown or riding saddles.]

BRUSHES.

There are several manufacturers of this kind: they make principally for home consumption, the export small. Number of workmen employed, about 100; earnings, 24*s*. to 25*s*. per week.

In reference to the local condition of the people, it will be found to stand quite on a level with Birmingham and Wolverhampton, the average earnings perhaps slightly exceeding either of them; if the standard of temperance were higher, the position of the working classes would be still further improved, but it is to improvidence of expenditure rather than to want of employment that we may trace poverty where it exists in the district. A large number of Irish have settled in this town; they find a general demand for their labour in the mines, iron works, and building trades, and are usually a well-conducted class of men and anxious to improve their position; they obtain 15*s.* to 17*s.* per week, and number not less than 5,000.

Addenda.

The number of workshops for the manufacture of bits, harness furniture, and general saddlers' ironmongery in Walsall and Bloxwich is 250.

The number of factories in Walsall for the manufacture of saddles, bridles, and harness is 80.

In the latter branches, the proportion of females employed average sixty per cent., but many are allowed to work at their own homes, as harness stitchers, thus preventing the usual ill results of female employment in factories. The latter work has recently been much accelerated by the introduction of the sewing machine, which enables one woman to do the work of twelve girls.

Of bits there is a numerous variety made, both of forged and cast iron. The most favourite pattern is known as the "Pelham." Buckles are made both of brass and iron, and include the descriptions known as "tongue," "roller," "brace," and "gear" buckles. Stirrups are also made to suit every whim of equestrians. The descriptions largely in request are the "Victoria," "The Ladies' stirrup," and the "Devonshire slipper."

Locks (wrought iron pad) are made from 7½*d.* per dozen upwards, and are sent chiefly to India and the Levant. One firm makes 5,000 dozen per week.

Over 3,000 pairs of spectacles are made here weekly. The manufacture of steel shoe buckles, once so prosperous here, is now quite extinct, the "silver buckled shoon" of yore having succumbed to the introduction of Wellingtons and elastic sides.

CHAINS, CART GEARING, AND HAMES.

The leading kinds of chains made here are curb chains, dog chains, and trace chains, all of which are forged. Curb chains are polished and plated, both in brass and silver. Dog chains are polished and japanned, and trace chains brightened in a revolving barrel.

Cart gearing consists of backband, hooks, rings, and swivels. Backbands, or the chain crossing the saddle from either shaft, are forged, varying in weight from 4 lbs. to 12 lbs. Hooks, rings, and swivels, are both forged and cast in malleable iron.

Hames are of various descriptions. Some are made entirely of wrought iron and polished (for cart horses), others are made of malleable iron, plated with brass or silver, or (in many cases) covered with patent leather, and some are made of wood, coated with polished iron.

STEEL AND IRON BITS AND STIRRUPS.

What are known as steel bits are made chiefly from a superior quality of iron made in the neighbourhood. Iron bits are both forged and malleable. The leading kinds are "Snaffle," "Pelham," "Military," and "Weymouth," for riding purposes, and corresponding patterns for driving harness. Stirrups are made in a variety of patterns, polished, and silver plated. The leading patterns are "Military," the "Ladies' stirrup," and the "Devonshire slipper."

Spurs are made in a great variety; some to screw in the boot of the rider, others to fasten with a strap, and peculiar patterns for the South American and other markets.

Harness ornaments are made for bridles, saddles, &c., in brass and silver plated metal, in a variety of patterns, including crests, rosettes, and other devices. These are chiefly made of stamped or cast metal, the former being filled with lead to give additional strength.

Buckles are chiefly cast of malleable iron. They are polished, japanned, tinned, silver plated, or covered with black leather for harness, and brown leather for bridles.

Brushes are also of great variety. The more prominent kinds are oil brushes, varnish brushes, shoe brushes, paint brushes, clothes, hat, and hair brushes, and others for household purposes.

Saddle-tree making is a distinct branch of trade; and the quality of the saddle greatly depends on the excellence of these articles. They are made of wood, and some are so constructed that they will yield to pressure.

Extracts from Government Report (1864).

The harness and saddlery trade is confined to Walsall. There are about fifteen factories, each employing from fifty to 100 hands. In the cutting, making up, and stitching saddles and bridles, adults and young persons of both sexes are employed, but few children, except in the houses of the workpeople. In one of the largest of these factories no girls under eighteen are employed. But in the manufacture of other parts of harness, the leather being thinner, the stitching can be done by younger hands. The introduction of sewing machines into these shops has dispensed with a great deal of the labour of the younger girls. With this machine one woman can do the work of twelve girls in stitching buckles. It is generally the custom for the men to do the harder work in the factories, the lighter work is given out to women to do in their own homes.

The saddle and harness factories at Walsall are very neat and well built. No heat is required in any of the shops except for the comfort of the workpeople. It is, however, too much the practice in these shops, as elsewhere where women are engaged in sedentary employment, to keep the shop very hot and exclude all fresh air as much as possible.

The hours of labour in these trades are from 7 or 8 a.m. to 7 p.m. In the harness factories, overtime to 10 p.m. is occasionally resorted to, but not very frequently.

The wages in the harness and saddlery trades are rather above the average. The earnings of workmen vary from 20*s.* to 45*s.* per week. The girls and women can earn from 8*s.* to 13*s.* per week. The wages of apprentices for the first year is 3*s.*, in the latter years of their apprenticeship they get from 12*s.* to 14*s.*

BLOXWICH.—AWL BLADES AND SADDLERS' IRONMONGERY.

The Rev. John Barrow, Incumbent, says:—"There is scarcely any employment for girls here; a few work at filing tacks. The apprentices in the awl blade and saddlers' ironmongery shops work very long hours—much longer than at Walsall in similar trades," &c.

THE STOURBRIDGE FIRE CLAY.

BY GEORGE HARRISON.

(WITH A TABLE OF ANALYSIS, BY D. FORBES, A. W. WILLS, &c.)

THE earliest account I have been able to obtain respecting Stourbridge fire clay shows that in the year 1566 a lease was granted for the purpose of getting and digging glasshouse pot clay. It is probable at that time it had only recently been discovered, and that its peculiar properties and purity, with the well known abundance of fuel in the neighbourhood, were the causes of the establishment of the glass manufacture, which was introduced by refugees from Lorraine about 1557. It is believed that one of the first glasshouses was erected in in a field (near to Stourbridge Station), which is known by the name of the Glasshouse Field at the present time. An old plan shows the position of the works, foundations of furnaces, and portions of old furnace. Bricks have also been found at Oldswinford, and other places in the neighbourhood. Dr. Pilot, in his History of Staffordshire (date about 1686), says:—"The most preferable clay of any is that of Amblecote, of a dark blewish colour, whereof they make the best pots for the glasshouses of any in England; nay, so very good is it for this purpose that it is sold on the place for 7*d.* the bushel, whereof Mr. Gray has 6*d.* and the workman 1*d.*, and so very necessary to be had that it is sent as far as London, some time by waggon and some time by land to Bewdley, and so down the Severn to Bristol, and thence to London. The goodness of which clay, and cheapness of coal hereabouts, no doubt has drawn the glasshouses, both for vessels and broad glass, into these parts, there being divers set up in different forms here at Amblecot, Oldswynford, Holloway's End, and Coburnbrook."

Stourbridge clay *(properly so called)* is found only in a comparatively small district, say within a circle of not more than two miles—taking the valley of the Stour at the Lye as its centre, and at depths varying from three or four yards from the surface to 180 yards. Its position in the strata is in all cases below the thick coal, at distances varying from twelve to twenty-five yards, and it is generally overlaid by a shaly friable kind of coal called "*Batts*," from twelve to twenty-four inches thick. The thickness of the seam varies very much, rarely exceeding thirty-six to forty-two inches, and sometimes thinning down to five or six inches when close to faults or small disturbances in the measures, as may be supposed from the different positions in which the clay is found. The quality is very variable, in some instances being quite soft and easily wrought with ordinary mining tools, in others as hard as stone, requiring the use of powder to a large extent. There is also a great variation in its composition, arising, principally, from difference in the quantity of silica contained; a clay containing a small quantity of silica, say fifty per cent., contracting very much when exposed to intense heat. In order to show this difference in a practical form, I have had eight clays, from as many different mines in the Stourbridge district, prepared under precisely similar circumstances, subjected to the same heat, and all burnt at one time in the same kiln, the result showing the great variation and power of resisting heat in each, since in the eight samples hardly two are of the same size.* The chemical analysis of fire clay has been so fully gone into by Dr. Percy, Mr. Hunt (School of Mines), Mr. Watts, and others, that I do not propose to say more on the subject.† Supposing clay to be pure and free from mineral matters and impurities, its value for glasshouse purposes depends upon the proportions of silica and alumina, and whether they are chemically combined or free; since, if the silica is free to a large extent, the alkalies used in the manufacture of glass at once combine with the silica and render the clay valueless.

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* The eight bricks were all made in one mould, under the same circumstances, and all burnt in one kiln at the same time, showing the following different degrees of contraction:—

	No. 1.	No. 2.	No. 3.	No. 4.
	Lnth. Brdth. Thick.	Lnth. Brdth. Thick.	Lnth. Brdth. Thick.	Lnth. Brdth. Thick.
Size,	$4\frac{10}{16} \times 2\frac{13}{16} \times 1$ in.	$4\frac{11}{16} \times 2\frac{3}{4} \times 1$ in.	$4\frac{3}{4} \times 2\frac{15}{16} \times \frac{15}{16}$ in.	$4\frac{1}{4} \times 2\frac{10}{16} \times \frac{14}{16}$ in.
Weight,	15 oz. 1 gr.	16 oz.	16 oz. 1 gr.	15 oz. 1 gr.

	No. 5.	No. 6.	No. 7.	No. 8.
	Lnth. Brdth. Thick.	Lnth. Brdth. Thick.	Lnth. Brdth. Thick.	Lnth. Brdth. Thick.
Size,	$4\frac{11}{16} \times 2\frac{13}{16} \times 1\frac{1}{16}$ in.	$4\frac{9}{16} \times 2\frac{3}{4} \times \frac{14}{16}$ in.	$4\frac{9}{16} \times 2\frac{3}{4} \times \frac{13}{16}$ in.	$4\frac{9}{16} \times 2\frac{3}{4} \times 1$ in.
Weight,	17 oz. 2 gr.	15 oz. 1 gr.	13 oz. 2 gr.	15 oz. 2 gr.

† Appended to this however are a series of sixteen analyses made by Messrs. D. Forbes A. W. Wills, and Dr. Valentine.

The usual treatment of clay for glasshouse purposes is as follows :—After having been selected and passed through the hands of two or three people, it is broken into small pieces by women accustomed to its appearance, who throw on one side all pieces of discoloured and irregular clay. It is finely ground by heavy edge punners, and mixed with a certain proportion of burnt clay, or ground potsherds (old broken pots carefully picked). The proportion of burnt clay varies according to the nature of the clay, and also varies with the purpose for which the clay is to be applied. It is then mixed with water and tempered with the feet, and allowed to lie a considerable time (which should not be less than five or six weeks), when it should acquire great tenacity before being made into pots. These pots are built up by hand gradually, great care being taken that the last layer of clay is not allowed to become hard or dry, or it will not unite properly, and neglect in this respect causes the pot to give way in the furnace. The pots are dried very gradually, and are seldom fit for service in less than from nine to twelve months. When required for use they are gradually annealed in a kiln, or "*Pot arch,*" and are set in the furnace whilst red hot. The sizes of the pots vary very much. Those for flint glass, being covered at the top, weigh on the average from twelve to fifteen cwt. For bottle manufacture, and also for crown and sheet glass, they are open at the top, and are larger in size. Some of the pots recently used in one of the largest glass establishments being as much as twenty-eight to thirty cwt. each when dry. The pots or cisterns used for casting plate glass are much less, five to six cwt. each, to allow for their being taken out of the furnace when full of metal. The average duration of pots is as follows :—

In a Flint house	6 to 9 months.
,, Bottle works	4 to 7 weeks.
,, Crown and sheet . .	7 to 9 weeks.
Plate glass cisterns . . .	14 days to a month.

The consumption of best pot clay is about 12,000 tons per annum.

The clay, after the selection of the best pot clay, is allowed to lie in large heaps subjected to the action of the atmosphere, and is then used in the manufacture of fire bricks, gas retorts, &c., the demand for which has largely increased in the last eight or ten years. Some fourteen years ago it was computed that the quantity of bricks made yearly in the

Stourbridge district was about fourteen millions, the quantity is now more than double, or nearer thirty millions. The district has suffered very much from want of railway accommodation, having unfortunately been the site upon which what may be called *"The Battle of the Gauges"* was fought, and more money has been spent in Parliamentary contests alone than it would have cost to give the needful accommodation. Prior to the opening of the Staffordshire and Worcestershire Canal, about 1780, most of the pot clay was carried in the lump state on *pack horses* to Bewdley, where it was shipped on the Severn for the North, London, Bristol, &c.

The quantity of clay raised per week is estimated at about 2,000 tons, giving employment to some 1,500 or 1,600 people. The average earnings of a clay getter are from 22*s*. to 24*s*. per week.

The manufacture of gas retorts has largely increased within the last fifteen years. They were used first to the largest extent in Scotland and the North of England, being made by Newcastle firms; but since 1850 large quantities have been made at Stourbridge, and their use may now be said to be general in all gas works, although it is only a very few years since they were adopted by the towns of Manchester, Liverpool, and Birmingham.

The social condition of the people employed in the clay works is much improved, although there is still great room for a further advance. The district of the Lye claims the credit, or rather the *dis*credit, of having baited the last bull in the kingdom, and it was long celebrated for the breed of bull dogs, which have now disappeared. Since then a Mechanics' Institution has been erected, schools have been established, and I do not think at the present time that the district is below that of other mining localities in intelligence.

FIRECLAY.

The following analyses indicate the general chemical composition of some of the best known clays of this district; and, by way of comparison, the composition of several inferior samples is added.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Silica	59·97	57·45	67·69	72·25	72·19	74·76	79·24	78·79	73·38	70·32	75·99	68·44	70·06	67·69	57·64	11·06
Alumina	33·49	37·93	27·91	22·37	25·53	22·82	16·07	16·07	22·89	26·42	22·53	27·01	19·85	26·91	30·57	16·31
Protoxide of Iron	3·01	2·20	2·35	2·18	......	......	3·04	3.15	2·21	1·04	·97	2·47	4·22	2·44	6·43	12·09
Peroxide of Iron.	......	......	...	......	1·70	2·69	......	......	......	......	......			—	—	—
Protox. Manganese	trace	trace	......	......	......	......	......	......	trace	......	......	trace	—	—	—	—
Bisulphide Iron..	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	2·52
Lime	1·42	·92	·63	·58	·41	·60	trace	trace	trace	·36	·05	·73	2·25	·81	2·18	trace
Magnesia.........	·31	·15	·11	·22	·15	·40	......	......	trace	·43	......	·19	2·61	·74	1·54	trace
Soda	trace	trace	...	...	......	......	1·63	·96	1·51	1·40	·87	1·33	1·06	1·07	1·15	·07
Potash............	2·21	1·35	......	·88	......	......										
Chlorine	......	......	......	......	......	......	......	......	......	trace	trace	......	......	......	trace	—
Sulphuric Acid .	......	......	......	......	......	......	......	trace	......	trace	trace	trace	......	......	trace	—
Carbonic Acid ..	......	......	......	......	......	......	trace	......	......	......	......	......	......	...	·47	25·91
Phosphoric Acid.	......	......	......	......	......	......	trace	trace	—	—	—	—	—	—	—	—
	[illegible]	100·00	98·69	98·48	99·98	100·67	99·98	99·87	99·99	99·97	100·41	100·17	100·05	99·86	99·98	99·37
Water driven off at 212°	8·06	15·67	......	......	8·12	......	7·20	6·45	8·21	9·98	6·06	......	......	11·21	18·75	·63
Do. at red heat & traces of organic matter..	[illegible]		·40	·35												
Specific Gravity..	......	......	......	......	......	......	2·49	2·51	2·49	......	......	......	......	......	......	3·47

1-White fireclay from a bed about 9 feet thick, situated in the coal measures of Glascote Colliery, Tamworth, at a depth of 73 feet from the surface—makes excellent firebricks and crucibles, and burns perfectly white.
2-Black fireclay from same coal measures, the bed being 3ft.6in. thick, and situated 547ft. below the surface: well suited to, and largely used in manufacture of firebricks, sanitary pipes, &c.
3-Rufford's best commercial burnt clay, Stourbridge.
4-Burnt Tintam Abbey clay, do.
5-Best raw do. do. do.
6-Burnt seconds do. do. do.
7-Tintam Abbey clay, from general heap.
8-Tintam Abbey best glasshouse pot clay.
9-Homer's do. do., Stourbridge
10-Average of four best clays, from Lord Stamford's pits, Amblecote.
11-Best glasshouse pot clay, Tamworth.
12-Fragment of "potsherd," from "Lower Delph" clay.
13-Fragment of "potsherd," from faulty glasshouse pot—inferior clay.
14-Clay from "Lower Delph."
15-Inferior clay, of weak mixture, rejected as unfit for use—Tintam Abbey.
16-"Cannock," picked out of Tintam Abbey clay.

1 & 2—By David Forbes, F.R.S.
3 & 4— ,, George Gore, F.R.S.
5 & 6— ,, Dr. Valentine.
7 to 16— ,, A. Winkler Wills.

THE MIDLAND SALT WORKS.

AMONG the mineral productions of the Birmingham district, salt is by no means one of the least important. A stratum of rock-salt of varying thickness extends under a considerable portion of the Worcestershire red sandstone, furnishing a practically inexhaustible supply of the raw material, which is manufactured into the salt of commerce at extensive works at Droitwich and Stoke Prior. The salt manufacture at Droitwich dates from a very early period. Dr. Thurnam's identification of this town with the "Salinæ," mentioned by Ptolemy as one of the principal cities of the Catieuchlani, though countenanced by the position assigned to that station in some copies of the Greek geographer, cannot on other grounds be accepted as conclusive; but it is far from improbable that the "Salt Way" may have borne the produce of the Worcestershire brine-springs into the Eastern counties during the period of Roman occupation, if not for centuries before. In Saxon days, however, we have distinct evidence of the existence of a salt manufacture having been established on the spot. The Huicci, mentioned by Saxon writers as dwellers in the Midland district, probably received their name from the "wiches" or salt-springs in the neighbourhood, and grants of these "wiches" are still extant, made by several of the Saxon kings. Domesday Book, also, affords conclusive evidence of salt having been manufactured at Droitwich in the time of Edward the Confessor. At that time, probably, the brine was obtained from springs at the surface, or from wells of inconsiderable depth. Even so late as the middle of the last century, few of the wells were of a greater depth than thirty feet, those now in use being generally four or five times that depth, and yielding a far more copious as well as more strongly impregnated supply.

The salt manufacture at Stoke is quite of a recent date. More than fifty years ago chemical works were established on the spot, and one shaft was sunk to the salt rock below, but for some years only a comparatively small quantity of salt was manufactured. Eventually three other pits were sunk, at a cost of £45,000, one of which occupied many years in completion owing to the formidable streams of fresh water which found their way into the borings—a constant source of expense in nearly all the Worcestershire brine pits. Those worked at Stoke Prior are the deepest in England, and the works, which cover about 17 acres, were erected at a total cost of about £450,000. The stratum of rock-salt lies considerably further below the surface than at Droitwich, but the brine holds a larger quantity of salt in solution, the proportion of saline matter being in the former case forty-two, in the latter about thirty-eight per cent., and other circumstances have contributed to attract to the Stoke Works a large share of the trade formerly enjoyed by their more historic rivals.

The system pursued is in all cases almost identical. An Artesian shaft is sunk into the bed of rock-salt, from which the brine is pumped into a reservoir. From thence it flows into large shallow pans where the water is evaporated at various degrees of heat according to the quality of salt required. When the salt has crystallised, it is removed from the pans and dried, the finer qualities in moulds, the coarser without undergoing any further process. At the Stoke Works there are three shafts into the stratum of rock-salt, which is here twenty-five feet in thickness. Wells, six feet in diameter, are sunk to a depth of 330 feet, and borings, four inches in diameter, continued for another 300 feet, the entire depth from the surface to the salt rock being at this point no less than 217 yards. At a depth of 285 feet, landsprings occur, and the whole of the wells and borings below are protected by a casing of copper in order to prevent any fresh water entering the shaft; most of the older wells at Droitwich being protected for the same purpose by a thick casing of clay. In the wells thus formed the brine naturally rises to about the same level as that at which the landsprings occur, and is pumped from this depth by steam power into a capacious reservoir, where it is slightly warmed by the waste heat from the engines before passing into the pans; the various contrivances for economising heat forming a conspicuous feature in the entire arrangement of the works. The pans are of wrought iron, about two feet deep, with an area containing from 400 to 3,350 superficial feet, heated by furnaces from below—three furnaces to each pan being the general allowance. A pathway, on which the workpeople ply their operations, runs round each pan, and the whole are under cover. Thirty-six such pans are devoted to the manufacture of fine or "square" salt, so called from the shape into which it is moulded, and a proportional number to other qualities. The quality of the salt varies according to the heat at which the water is evaporated, the salt being finer in proportion to the heat. The principal qualities manufactured are four:—1. Baysalt, the coarsest, produced by evaporation at a heat of only about 60°. 2. Fishery salt, as its name implies, principally used in curing fish, requiring a heat of about 70°. 3. "Broad" salt, principally used for chemical manufactures, and requiring a heat of about 90°. 4. "Fine," "square," or "table" salt, in making which the brine is kept at about the boiling point, 212°. Besides these there are several minor varieties, "brisk" salt, "basket" salt, "Sunday" salt, "bough" salt, "hopper" salt, and "butter" salt. Of these, "hopper" salt, made by grinding the fine salt, is manufactured for the most part in London, where the principal demand exists for the finest kinds. "Butter" salt is the finest kind usually manufactured, and a peculiar variety of it is now manufactured at the Stoke Works, in circular covered pans, the brine being constantly stirred by a contrivance similar to that used in the paper manufacture for stirring the pulp, and kept continually at boiling point. The salt thus produced weighs heavier in proportion to its bulk than any other kind, and is used, among other purposes, for mixing with "broad" salt for the Russian market—the Russian consumer requiring his salt to weigh eighty-one pounds to the bushel, while ordinary salt only weighs seventy-one pounds to the same quantity.

The brine pumped into the pans holds several substances besides salt in solution, the principal being carbonate and sulphate of lime. When the salt crystallises, these substances fall to the bottom of the pans, where they form a hard white semi-transparent cake called "pan-scratch" or "scale," which is pecked up and cleaned out when it attains a thickness of three or four inches, a process terribly increasing the wear and tear of the pans. This substance is afterwards ground, and sold as "agricultural salt," largely used for manure, but in some cases not impossibly available and more valuable for other purposes.

It is evident that the time employed in the manufacture of the several kinds of salt varies greatly according to the difference in the rate of evaporation, a week or ten days being required in the case of the coarser kinds and a few hours only in the case of the finer. Crystallisation commences at the surface where the evaporation takes place, the crystals forming a thin crust resembling ice. The specific gravity of the crystals being heavier than that of the brine, they gradually sink to the bottom in larger or smaller flakes, a crust sometimes forming over the whole surface of a pan and sinking altogether. Crystallisation having once set in, the crystals "feed themselves" after sinking to the bottom, and increase in size. When the crystals thus form at the top and sink, the pan is said to "work," and the skill of the workman consists in managing the furnaces and the brine so as to get his pan to work favourably. A very small disturbing element, a candle end or a drop of oil, is sufficient effectually to prevent the "working" of an entire pan, and the addition of half a spoonful of carbonate of soda will make a difference of many pounds in the weight of the salt per bushel, by altering the delicate conditions which affect its crystallisation. In some of the Cheshire works, the quality of the brine requires the addition of glue or other gelatinous matter before the pans can be got to "work," and in all, the least chemical disturbance makes itself perceptible in the result. When the salt has settled at the bottom of the pans in sufficient quantity, it is raked out with large wooden hoes, the "fine" being pressed into wooden moulds of a square section about two-feet long and somewhat tapering towards the bottom, called "tubs," which are then set to drain. When the salt is sufficiently drained, it is slipped out of the tubs and set to dry.

Such is an outline of the main processes in the salt manufacture. No great improvements or alterations have been introduced into it beyond the application of steam-power, and more modern methods of sinking wells, since Mr. Lowndes was rewarded by Parliament at the commencement of the last century for the improved system he had inaugurated at his works in Cheshire, and which has since been universally adopted. The manufacture of the "butter" salt in closed pans, already described, is perhaps the most notable modification introduced in any department of late years.

The social condition of the salt workers has for centuries been, and in most cases continues to be a reproach to English civilisation. The heat of the stoves and pan-houses in which they work, and which frequently better deserve the name of their homes than the miserable hovels in which they huddle out of working hours, renders more than a minimum of clothing unnecessary if not burdensome, and even this minimum is not unfrequently dispensed with by both sexes. The work is necessarily continuous day and night, and from Monday morning to Saturday evening it often happens that the labourer never quits the precincts of the works, snatching his intervals of rest beside the pans. Men and women, boys and girls, are thus exposed to more than all the debasing and demoralising influences which haunt the worst dwellings of our agricultural labourers, without a single antagonistic agency to prevent their lapse into the lowest depths of brutish immorality. The social condition of the saltworkers has consequently been, and probably still is, more abjectly degraded than that of any other class equally numerous, although their poverty is by no means so depressing. With scarcely an exception, wherever salt manufactures on a large scale have existed, the population employed in them has been the disgrace and pollution of the neighbourhood, a community almost unapproachable by philanthropy and irreclaimable by religion. Happily we are able to record the dawn of better days in the district nearest to Birmingham.

It is now eight years since the employment of women at the Stoke Works was entirely discontinued by the proprietor, John Corbett, Esq., and although the full result of the measure will not be felt until a new generation has arisen, it has already acted on the habits and condition of the workpeople in such a manner as to produce a social revolution in the neighbourhood. Marriage, an institution previously almost ignored, has in a great measure superseded the indiscriminate concubinage resulting from the former conditions of labour; the dwellings of the workpeople, now continuously occupied, have very perceptibly improved, and if the condition of the saltworker from a social and moral point of view is still greatly lower than that of the average artisan, it is far higher than it ever has been, or indeed, could be, under the old system. The reformation thus effected has also been materially aided by an alteration in the arrangement of the work introduced about five years ago. Formerly, one man only was usually appointed to take charge of each pan both by day and night, and was paid at the rate of 1*s.* 10½*d.*, per ton of salt manufactured. In place of this system, what is termed "shift work" is now universally adopted at the Stoke Works. Two men, one for the day and one for the night, are appointed to each pan, and receive 2*s.* per ton proportionally divided between them, the higher rate of payment being compensated by the additional amount manufactured under the new system. Three assistants are required to each pan, who are paid by the men in charge of it out of their receipts for the salt manufactured. Much of the work can be done by boys and girls, and a father, by taking his children as his assistants, could make a considerable addition to his wages. A strong inducement is thus held out to parents to employ their children in such a manner as wholly to preclude their chance of obtaining any education, although at Stoke the inducement no longer exists in the case of girls. All the work is paid by the piece, and even in processes apparently so simple, an amount of judgment, experience, tact, and dexterity is required which makes a wide difference between the wages of a good and a bad workman. A fair workman on an average, at 2*s.* per ton, can it is calculated make about 28*s.* per week. Each head of a pan is paid 22*s.* weekly on account, and the balance is settled monthly, the work being appraised by the foreman of the salt works, who rejects or reduces the allowance for work in any way faulty or imperfect. About 500 hands are employed at Stoke Works, and the average amount of salt of all kinds manufactured is about 3,000 tons per week, with a consumption of from 1,500 to 2,000 tons of fuel. Previous to 1823, when the duty on salt, then as high as 15*s.* per bushel, was repealed, the entire annual produce of Droitwich did not amount to more than 9,000 tons, the entire produce of Worcestershire being now about 200,000 tons per annum. The Cheshire salt works are capable of producing a million tons per annum, but the supply being immensely in excess of the demand, many works are always standing both in the Cheshire and Worcestershire districts. The export trade of Worcestershire is about 50,000 tons annually; that of Cheshire about 650,000 tons.

The price of salt for many years has ranged within very narrow limits. Monthly meetings are held by the manufacturers, as in other trades, and arrangements made as to the rate of wages, the prices to be charged, and other matters affecting their common interests. The number of "small masters" in the trade, however, renders any effective combination among the manufacturers as difficult as the introduction of any substantial reform in the habits and condition of the workpeople. A large portion of the trade in the aggregate at Droitwich is in the hands of such masters, who, not possessed of sufficient capital to undertake the manufacture on a scale large enough to permit the adoption of expensive improvements in machinery, or in the system of working and payment of wages, are still able, by employing their own family as workpeople, to produce salt at a rate so low as to render it difficult for those able to initiate the necessary reforms to realise an adequate remuneration from them. On the whole, therefore, although the experiment tried at Stoke has we believe been commercially as well as socially successful, and must in the long run materially affect the condition of the saltworkers, there is but little immediate prospect of their making any great general advance in the social scale. For the present the public is able to purchase salt at a price possibly lower by some infinitesimal fraction than it would be if the manufacture were entirely in the hands of large proprietors and the employment of women and children strictly prohibited; but the advantage is dearly purchased by the continued existence amongst us of a class of labourers which ranks below that even of the working colliers.

THE CERAMIC MANUFACTURES OF STAFFORDSHIRE.

By H. COGHILL.

According to tradition, this manufacture was first established by the Romans, but, judging from the etymology of the various names comprising the district, the Saxons were the more probable founders.

Until the time of Wedgwood, but little progress had been made in the potters' art. We find that in 1738, the entire population of the Potteries was only 4,000; in 1811, 31,010; in 1838, 63,000; and in 1864, it had increased to 123,694; of which only 27,878 were operatives directly engaged in this branch of trade, and of this number 10,598 were females.

At the present time the trade is carried on by 170 firms, the estimated value of whose productions is £2,210,000 per annum, of which sum fully one-half is disbursed in wages.

The quantity of prepared clay annually consumed is about 160,000 tons. The proportions of this required in the manufacture of earthenware and china are as follows, viz.:—

EARTHENWARE.	Per cent.	CHINA.	Per cent.
Dorsetshire & Devonshire Clays	28	Calcined Bone, or Phosphate of Lime	43
Cornwall Clay	26	Cornwall Stone	30
Flint	29	Cornwall Clay...	27
Cornwall Stone	17		
	100		100

The annual consumption of coals in the trade may be stated at 450,000 tons. To stain the clay, and print the ware, about 67,000 lbs. oxide cobalt is used, and about 1,100 tons borax and boracic acid to glaze it, and 12,000 ounces of gold are required to gild and embellish the same.

The calcined bone used in the manufacture of china is about 4,500 tons per annum, principally from South America.

We stand in an unrivalled position for this manufacture, as our clays, our cheap coals, and facilities of transport are very commanding advantages. Still, it is a fact that for years past the trade, as a whole, has not been remunerative; no doubt arising in part from the great strike of the operatives in 1837, and consequent dispersion of the trade to Newcastle-on-Tyne, Glasgow, and other parts of the kingdom, and also from the want of enterprise displayed by our manufacturers in not adopting machinery so as to diminish the cost of production. Look at the enormous amount paid for labour, a large portion of which, by the introduction of machinery, might be economised, to the gain of the master and the comfort of the men. One may see machinery successfully employed in continental potteries; also in some of our northern potteries. Ceramic wares to the extent of £700,000 per annum are now made in the out-potteries.

EXPORTS.

The exports in 1850 amounted to £999,448, being 50 per cent. more than they were in 1836. The increase in the next 14 years is in about the same proportion. The total exports for 1864 amounted to £1,422,130, which leaves for home consumption the large sum of £1,487,870, showing the vast importance of the home trade. The much-vaunted French Treaty has not much benefitted this branch of trade, as the exports to France in 1863 only reached £51,701, and in 1864 to £53,982. The French being quite capable of supplying their own wants, an extended demand from that quarter need not be looked for. Much attention has been of late drawn to the use of poisonous ingredients in glazes, and their injurious effects on the workmen. It is quite practicable to dispense with them all with advantage both to master and men. The following formula has been found to answer satisfactorily in practice:—

75	lbs.	Crystallised Boracic Acid (84 per cent).
75	,,	Crushed Soda Crystals, or its equivalent in a dry state.
75	,,	Cornwall Stone, or Felspar.
80	,,	Flint, ground, or Silex.
13	,,	Cornwall Clay.
50	,,	Carbonate of Lime.

The above to be fretted in a furnace in the usual way.

Take	460	lbs.	Fret as above.
	150	,,	Cornwall Stone.
	50	,,	Cornwall Clay.
	20	,,	Carbonate of Lime.
	20	,,	Flint, or Silex.

The above ground in water in the usual way, and strained as required.

ON THE MANUFACTURE OF PLATE, CROWN, AND SHEET GLASS.

BY HENRY CHANCE, M.A.

CAST plate glass is manufactured at Smethwick, at the works of the Birmingham Plate Glass Company; crown, sheet, and rolled or rough plate glass at Smethwick, by Messrs. Chance Brothers, and Co., and at Stourbridge by the Stourbridge Glass Company (Limited).

PLATE GLASS.

Mr. Swinburne, in his report on the glass manufacture of the Newcastle district, says:—"The art of casting plate glass, by throwing the molten material on an iron or copper table and rolling it into a plate of equal thickness, was first adopted in England in 1771, in Lancashire, but there is abundant proof that plate glass of smaller dimensions was made before that time at South Shields. An article called blown plate glass was made at that place in the early part of the seventeenth century, and the manufacture was continued until the year 1845." The process was very similar in principle to that of making sheet glass, differing only in some mechanical contrivances to enable the workman to handle the heavy weight of glass required for the purpose.

In 1836 the production of plate glass in the United Kingdom was not more than 7,000 feet per week. In 1845 the duty on glass was abolished, and the weekly produce has increased since that time to 140,000 feet—an increase which has taken place in spite of a very large importation of this description of glass from France and Belgium.

In 1771 the price of a mirror of plate glass, 50 inches long by 40 inches wide, was about £60; in 1844, before the repeal of the duty, about £10, and now it is less than half that price.

CROWN AND SHEET GLASS.

The first works of note established in this country for the manufacture of crown glass were those of Sir Matthew White, Ridley, and Co., on the River Tyne, at Newcastle, in the middle of the seventeenth century. From that time up to the period at which the manufacture of Bohemian sheet glass (introduced from France in the year 1832) was firmly established in England, crown glass was used for all houses of the better class, but of late years the crown glass trade has shown symptoms of decline, in spite of the great improvements which have been introduced in the process, and also in spite of the stimulus given to all kinds of glass by the abolition of the duty. The waste caused by cutting up circles into rectangular pieces, the limitation of the size of these pieces by the bull's eye or lump in the centre of the circle, as well as the difficulty of obtaining an uniform thickness, have contributed to the gradual substitution of cylindrical or sheet glass in the place of crown.

A very rude kind of sheet glass, called German spread glass, was manufactured in England prior to the introduction of Bohemian sheet glass. The cylinder was cut open while hot with a pair of shears, and spread out immediately upon a plate of iron covered with sand.

In the year 1832, the manufacture of Bohemian sheet glass was commenced by Mr. Robert Lucas Chance and Mr. James Hartley, but so numerous were the difficulties to be overcome that it was not completely established until the year 1838. At that time the art being new to England, foreign workmen exclusively were employed in the operation of blowing the glass, but Englishmen have been gradually initiated into the process, and the manufacturer is now able to dispense in a great degree with foreign assistance.

The size at first usually blown was 36 inches long by 20 wide. Now cylinders are occasionally blown 77 inches long, and the usual size is from 45 to 50 inches long, and 32 to 36 inches wide.

A further development of the sheet glass manufacture in England was the process of grinding and polishing this glass, invented by Mr. James Chance, whereby a new branch of manufacture was established, which has furnished glass peculiarly applicable to purposes for which none previously existed. This glass is known by the name of patent plate.

A great stimulus was given to the manufacture of crown and sheet glass by the abolition of the duty in the year 1845.

In 1844 there were fourteen companies engaged in the manufacture; in 1846 and 1847 following the repeal of the duty the number had increased to twenty-four. This rapid increase of the number of manufacturers was accompanied by an enlargement of many of the works already in existence. The supply became greatly in excess of the demand, and the result was that in 1854 out of the twenty-four companies but ten were left. There are now only seven in the United Kingdom, all of which are in England, but three of the whole number, namely Messrs. Chance, Messrs. Pilkington, and Messrs. Hartley, manufacture seventy-five per cent. of the whole quantity produced.

The price of good crown glass has fallen from about £12 per crate in 1844, prior to the repeal of the duty, to £2 8*s*. in 1865; and of ordinary sheet glass from 1*s*. 2*d*. to 2*d*. per foot during the same period.

ROLLED PLATE GLASS.

About the year 1850, Mr. Hartley introduced the economical and successful method of making sheets of rolled plate glass, when not required to be very large, by conveying the melted material from the glass pot to the table in ladles, instead of emptying upon it the contents of the whole pot.

This kind of glass is now made by most of the manufacturers of crown and sheet glass.

IMPROVEMENTS.

The processes employed at the present time in the manufacture of crown, sheet, and plate glass are substantially the same as when these products were originated; but many improvements have taken place during the fifty years which have elapsed from the commencement of the manufacture of window glass in this locality. Among these may be mentioned:—

1. The substitution, about the year 1830, of carbonate of soda as the alkaline ingredient in glass in the place of kelp, and, subsequently, for crown and sheet glass, of sulphate of soda in the place of carbonate.
2. An increase in the size and improvement in the workmanship of the plates, sheets, and tables produced.
3. An improvement in the colour of the glass by the use of purer materials, and modifications in the process of melting.

4. Numerous improvements in the flattening of sheet glass, resulting in the removal or diminution of many imperfections.
5. The use of the diamond in the process of splitting cylinders in the place of a red hot iron.
6. An increase in the size of the melting pots and furnaces, with the view of economising coal and labour.
7. The adoption, in the casting of plate glass, of various mechanical contrivances. The origin of some important improvements of this class is due to the present manager of the Birmingham Plate Glass Company.
8. The use of the same pot for the two processes of melting and casting plate glass, superseding the old method of transferring the contents of the melting pot into the vessel used for casting.
9. The substitution of small coal or slack in the melting processes, in the place of large coal or lumps.
10. The application of Siemen's regenerative process to the melting of glass, by which the amount of smoke is greatly diminished, the colour of the glass is improved, a greater control is obtained over the furnace, and a saving of fuel is effected wherever by this process slack can be substituted for large coal or lumps. These advantages are to some extent counterbalanced by the largely increased cost of the furnace, and its liability to get out of order. The process, however, as applied to glass making is so new that there has been scarcely time as yet to overcome the difficulties which have presented themselves.

STATISTICS, ETC.

The following statistics have reference to the three works already named, taken in the aggregate :—

Wages paid yearly	£120,000	
Coal used do.	165,000	tons.
Sand do. do.	10,000	,,
Alkali do. do.	4,500	,,
Chalk or limestone	3,500	,,
Glass produced	17,000	,,
Workmen employed	2,500	

REPORT ON GLASS WORKS AT WORDSLEY, AMBLECOTE, STOURBRIDGE, AND DUDLEY.

By W. MADELEY.

THE manufacture of glass in this neighbourhood seems to have been established very soon after the immigration into England of the continental workmen, and, doubtless, is owing to the existence of the fire clay which is found here, the quality of which for "glass-house pots" has long enjoyed a world-wide fame. For two centuries this trade was only carried on to a very limited extent, but within the last century has been considerably developed, and this is now the chief source of the supply of flint glass articles for our home consumption. The foreign manufacturers, owing to cheapness of labour, &c., shut us out from foreign markets, but the home demand has greatly increased even within the last few years.

There are at the present time—

	10	Flint glass works,
	1	Plate and crown glass works,
	2	Bottle glass works,
Total,	13	

in operation in this neighbourhood; employing—

	1,200	men,
	150	women and girls,
	350	boys,
Total,	1,700	

The sand used formerly was brought from Lynn (Norfolk), and the Isle of Wight, but that from Fontainebleau is now used exclusively.

The average wages of the workmen range from 33*s*. upwards, and the women and girls, whose employment chiefly consists in frosting and packing, receive about 6*s*. per week.

As may be inferred from the delicate nature of the material and the skill required in the manufacture, the workmen possess considerable intelligence and education, and freely avail themselves of the various institutions in the neighbourhood established for the intellectual improvement of the working classes.

LIGHTHOUSE ILLUMINATION, AND THE DIOPTRIC APPARATUS.

BY JAMES KENWARD.

AN account of the manufactures of Birmingham or of South Staffordshire would obviously be incomplete if it failed to comprise the manufacture of lighthouse illuminating apparatus on the dioptric system, which is carried on by Messrs. Chance Brothers and Company, at their glass works at Spon Lane. Yet this undertaking has no connection whatever with any of the trades that give a character to the locality. It is indeed the only one of its kind in the United Kingdom, and one of the only three, or perhaps four, in the world, the others belonging to Paris.

It has been carried on for about fifteen years by the Messrs. Chance, and, especially within the latter half of that period, has attained such dimensions, and promoted such results as entitle it to no mean place among the enterprises which contribute to the benefit of the nation, or to the advancement of science.

The history of lighthouse construction and illumination is one of large extent and deep interest. The literature of the subject is now very ample and very generally known. It embraces a period of two thousand years, from Ptolemy Philadelphus to Victoria. It includes all kinds of towers, from the Alexandrian Pharos to the Calf Rock Tower reared but recently upon the wildest of the Irish seas. It comprises all varieties of fuel, from wood, and coal, and tallow, to oil and gas and electricity; as also many successive specimens of apparatus on the two great principles of reflection and refraction.

Architecture had attained a high degree of excellence at a time when lighthouse optics and mechanics were wholly undeveloped.

When the magnificent Tour de Corduan in France was completed (in 1610) it was arranged for the cumbustion of oak wood, exposed in an open chauffer; and the fine shaft of the Eddystone was in 1759 decorated with a crown of twenty-four candles, weighing in all about ten pounds—a system continued for nearly half a century. The Bell Rock light in the Frith of Forth was, from 1636 to 1816, an enormous coal fire, giving little effective light, and costing large sums for maintenance. In the latter year it was supplied with oil lamps and reflectors. A similar change was made seven years later in the St. Bees' Head light on the west coast of England.

The invention of the argand lamp, with its double stream of air, and, subsequently, the invention, or rather the adaptation, of the parabolic reflector, was an immense benefit to the lighthouse service.

The honour of this application of the reflector has been claimed for M. Teulère, or for the Chevalier Borda, both of whom were instrumental in fitting the Corduan light with these mirrors; but an Englishman, William Hutchinson, as early as 1777, had made reflectors to the parabolic curve, which were used in the Liverpool lighthouses. These reflectors were composed of small facets of silvered glass, and the desired figure was given by a plaster mould. The parabolic reflectors as arranged and improved by Captain Huddart, Professor Leslie, Mr. Robert Stevenson, and others, and as used in existing lights on the catoptric system, are very effective instruments compared with all that preceded them. The power of a full-sized silvered copper reflector, say of twenty-four inches diameter and four inches focal distance, with its argand lamp, has been estimated at about 450 times that of an unassisted flame. The divergence of light in such a reflector, with a flame one inch in diameter—that is, the scattering of the rays passing from the outer portion of the flame, which are not sent parallel—is equal to about fourteen degrees, and this amount is a favourable circumstance in the reflector system, as it increases the lighted area very considerably, though, of course, the light is unequal.

Metallic reflectors, when well made and properly managed, constitute useful and durable apparatus, and there are many good examples of lights, especially revolving lights, on the catoptric system.

But this system under its best forms is still vastly inferior to the dioptric system, that is, illuminating by lenses, which has been called into being by the increasing progress of science and the increasing needs of commerce. A keen controversy has been excited by Sir David Brewster's claim to be *pro tanto* the British inventor of the lighthouse lens, but there is not sufficient evidence to justify such a position.

In 1812, Sir David, it is true, proposed a polyzonal lens, *i.e.*, one built up of concentric pieces; but Buffon and Condorcet had suggested such a lens as far back as about 1773, and the instrument had actually been made by the Abbé Rochon, in 1780. And, moreover, these polyzonal lenses were intended rather for burning glasses than for agents for distributing light.

The real honour and credit must be accorded to Augustin Fresnel, who, in 1819, brought out the celebrated annular lens for revolving lights, and *de facto* originated the dioptric system of illumination, that is, by lenses acting on the light of a single central lamp. He also invented this lamp. His lens of the largest size, or of what is termed the *first order*, about three feet three inches in height and two feet six inches broad, as it still remains, was composed of zones or rings of polished glass—crown glass—cemented together. It had an illuminating power when lighted by the four-wick lamp, of about 3,000 unassisted argand flames, or of about seven reflectors of the largest size, lighted by seven argand lamps. Fresnel set up his revolving light in the Corduan Tower in 1823. He afterwards introduced the cylindric lens for fixed lights, but, as will be noticed presently, did not apply the prisms at least for the largest apparatus of this form.

The Government of France at once applied the invention to the numerous lighthouses then under construction, and from that day to the present they have not failed to erect lenticular lights on every occasion, in preference to all others. The Dutch followed next in the application of the new system.

The Scottish Lighthouse Board placed, in 1835, a revolving dioptric light on Inch-Keith, and in 1836, a fixed light on the Isle of May, in substitution in both cases for catoptric apparatus. The Isle of May light was successfully constructed by Messrs Cookson, of Newcastle.

The Trinity House, of London, erected their first lenticular light at the Start in 1836. Nearly all maritime Europe followed in gradual succession; and, lastly, the Government of the United States, having charged a scientific commission to investigate the two methods of illumination, proceeded to erect along their vast coast line a series of lens lights, either in new towers or in substitution for reflector lights. This wise and active policy has prevailed to the present day and at least 500 lights attest its unqualified success.

But dioptric lighthouse apparatus, although it began with Fresnel, did not end with him. Fresnel used for his revolving lights, in addition to the central annular lenses, a certain combination of refractors and reflectors, formed of silvered glass mirrors, in order to intercept that portion of light which would pass above the lenses. This portion of his apparatus has been superseded by the totally reflecting holophotal prisms of Mr. Thomas Stevenson.

These zones, placed both above and below the lenses, are concentric with the centre of the lenses, and as the entire apparatus revolves, the whole light is projected to the horizon in flashes of the entire height of the apparatus. The holophotal system has been applied by its inventor to other forms of apparatus with excellent results. With regard also to Fresnel's fixed light, Mr. Alan Stevenson was the medium of valuable improvements. Fresnel had designed a series of totally reflecting prisms, to be ranged above and below the central belt, so formed as to intercept all the rays falling on them, and to project them in a direction parallel to those issuing through the central belt. Finding certain difficulties in the construction of these prisms, he employed instead a series of inclined metallic mirrors and reserved prisms for harbour lights. But Alan Stevenson, in concert with Léonor Fresnel, brother to Augustin, secured the adoption of the totally reflecting prisms, and, in addition, proposed to make the sections of the central hoop of refracting lenses *rhomboidal*, so that the junction of the central frames should not intercept light in any azimuth.

The eminent family of lighthouse engineers, Robert, Alan, David, and Thomas Stevenson, have introduced or promoted several other improvements, the general effect of which has been to augment the power, or to diminish the expense of lighthouse apparatus. Comparisons of the two systems of illumination were for the most part made at a time when the catoptric apparatus had been brought to a state of perfection, but when full justice had not been done in the manufacture to the dioptric apparatus. Until within the last few years, the upper and lower totally reflecting prism were so defectively shaped, that the light proceeding from the central flame was not condensed into parallel beams, but was sent out with so much divergence that a small portion only of each prism was effective to the eye of the mariner. This inefficiency was still further increased by bad adjustment, so that the various prisms, instead of conveying the brightest part of the flame to the sea, wasted it upon the sky. The refracting portion also was very imperfectly made. These defects modified very considerably the legitimate power of the best dioptric lights. Nevertheless, it has been incontestably shown that the effective value of a fixed light of the first order was *four times* or *five times* that of a reflector light of the same *nominal* power, although, in fact, *no* reflector light could possibly equal a dioptric light in the equal distribution of the rays.

The revolving reflector light approached much more nearly to the revolving dioptric. However, the United States Lighthouse Commission, after the most elaborate analysis ever made of the merits of the two systems, pronounced (in 1852) decisively in favour of lenses for *all* forms of lights. This investigation proved the economic value of the dioptric apparatus, lighted by the one lamp—that is, the measure of oil burnt—to be as *one* to *four*, compared with the reflector apparatus and argand lamps. Four times the power, with one-fourth the expenditure of oil, seems indeed an enormous ratio; but, assuming it to be overstated for thirteen years ago, there can be no question that a comparison of the best specimens of the respective apparatus of the present day would quite verify this proportion.

The French, who are the undoubted parents of dioptric lights, retained for many years the exclusive manufacture of them.

Soleil, Letourneau, Sautter, Lepaute, are names of deservedly high repute in this branch, all apparently having enjoyed the benefit of working under the immediate auspices of Augustin or of Léonor Fresnel. The excellent glass, too, supplied by the St. Gobain Company gave for a long time an advantage to the Parisian makers which no other country could share. But, above all, the direct and unwavering patronage accorded to them by their governments, the zealous recommendation of them by the diplomatic staff everywhere, and by the Lighthouse Department at Paris, armed these few makers with a vast monopoly, little calculated to enhance the improvement of dioptric apparatus, or to reduce its cost.

In England, where no such fostering influences prevail, the lighthouse manufacture has been planted with great difficulty, and its results in a commercial point of view have been very discouraging. Messrs. Cookson, after producing several lens apparatus, excellent for that day, were forced to abandon the undertaking with considerable loss. Messrs. Chance ventured on it, with the conviction that such a manufacture ought to be not less English than French, and that the exclusive resources at their command would enable them to occupy at least an equal position with the French.

Totally unsupported by Government, and unaided by Lighthouse Boards, they worked out, *ab initio*, the most important problems and processes, and centralised in their own establishment the fabrication of every part of the apparatus.

They have devoted to the lighthouse branch an area in their works of nearly an acre and a-half, a steam engine of fifty-horse power, a glass house for casting, about forty newly contrived machines for grinding with mathematical exactness, and polishing the lenses and prisms of all forms; as many lathes, planing and other machines, in the fitting shops, where lanterns, lamps, clockwork, and all metallic accessories are prepared; and, lastly, a staff of about one hundred workmen; but this, of course, is no measure of the magnitude of an enterprise where machinery plays so large a part.

It has resulted, from the position and practice of the French manufacturers, that the dioptric system communicated to them by Fresnel has remained almost stationary in their hands. Held by the Governmental arm, and thus ensured the custom of the maritime world, they had little inducement to do more than go on making apparatus of the original types without any thought or interest on the side of improvement, while their clients were at once ignorant of more perfect apparatus, and powerless to procure it. On the other hand, the English house having had to depend on the *character* of their apparatus for its adoption, having had to fight against prejudice abroad and apathy at home, has attained to a higher degree of excellence, not only in the colour and polish of the glass—in the fitting and shaping of the metallic framework—in the stability and precision of the machinery, and in the simplicity and strength of the lamps; but also in the accuracy of shape in the prisms, and in the proper adjustment of the prisms and proper placing of the lamp, according to the height of the tower and other local *data*, so as to direct the maximum of light to the sea horizon, or to any portion of the sea between the horizon and the tower as may be desired.

The merit of having introduced accuracy into the dioptric apparatus, and of having applied the system of adjustment, belongs mainly to Mr. James Chance. The French makers have almost wholly ignored the question of *dip*, and, which is of more consequence, have retained unimproved all that is defective in the shapes of the glass apparatus. The result is that the usefulness of most of their largest dioptric lights is seriously impaired.

The Messrs. Chance have been commissioned to readjust several of these lights for the English and Irish lighthouse authorities, and they have also begun to readjust continental lights of the same class. The effect of these readjustments has been an increase of power to such an extent as to excite the admiration of mariners who have remarked the unwonted brilliancy of some familiar light. This has been, of course, especially noticeable where the flame was habitually kept low, or where the tower was very high.

With regard to dioptric apparatus as at present constructed there are, as a rule, six "orders" or classes of lights, each being a hollow cylinder built up of lenses and prisms, varying in diameter from about six feet to one foot, and in height from ten feet to two feet. Each is susceptible of three chief modifications, namely a fixed light, a revolving light, and a light which is partly fixed and partly revolving. Arrangements of flashes and eclipses, of constant and intermittent light, are made to suit each case with regard to distinctiveness or to power. In the middle of the apparatus is placed a single lamp, having one, two, three, or four concentric wicks, according to its size. The lamp varies in form and construction, but the flame to be produced must be from about 4 inches high by 3½ inches diameter for a first order light, to 1¾ inches high by 1⅛ inch diameter for a sixth order. The burner is placed in such a manner as to allow the most advantageous optical action on the flame, determined by the required functions of the light, and by its elevation above the sea. To use the words of Mr. Alan Stevenson — "Nothing can be more beautiful than an entire apparatus for a fixed light of the first order. It consists of a central belt of refractors forming a hollow cylinder 6 feet in diameter and 30 inches high; below it are six triangular rings of glass ranged in a cylindrical form, and above, a crown of thirteen rings of glass, forming by their union a hollow cage composed of polished glass 10 feet high and 6 feet in diameter. I know of no work of art more beautiful or creditable to the boldness, ardour, intelligence, and zeal of the artist."

No less than eighteen prisms are now frequently adopted for the upper series, and eight for the lower, with advantage, because, not occupying more space than the thirteen and six prism arrangement, the sections are smaller and the loss of light by absorption is minimised, while the accuracy of form and ease of workmanship are increased.

The revolving light always has, in the first order, eighteen prisms above and eight below the annular lenses. It has attained its finest development in the holophotal system of Mr. Thomas Stevenson already mentioned.

A detailed account of the numerous combinations and modifications of which these apparatus are capable would be too long for the present paper. The principle of the lesser orders of lights is the same, and the superiority of the dioptric system extends *pro ratâ* to the smallest harbour apparatus.

A word upon the English manufacture of these lights. Each lens, ring, and prism of glass is cast in an iron mould. The rough casting is reduced to exact proportions by a grinding machine specially devised for it, where it is fixed in a bed of plaster on a revolving iron table, and acted on by rubbers which can touch two faces at once. It is then polished by similar contrivances, rouge being used here while emery is used for the grinding. After a final polishing by hand, and a careful verification of its accuracy and good quality, it is set with a peculiar cement in its gunmetal framework, if a prism; but if a member of the refracting or central portion, it is first joined to its fellow pieces and the whole compose the lens, which is then duly mounted in gunmetal. The prisms of a light are arranged in segments to correspond with the built-up lenses. All these segments are called "panels," and their number varies according to the order and character of the light. The panels are lastly connected by an armature of gunmetal or wrought iron, and the result is the radiant structure, like a huge beehive, of which an example was shown by the Messrs. Chance in the Exhibition of 1862, the same light that now flashes over the sea from the remote Island of Innistrahal in the north of Ireland.

When an apparatus is completely erected in the chamber devoted to it, it undergoes a searching examination in all points, and its fitness for its appointed work must be proved before it can be despatched to the coast. During the day examination every prism and lens is tested, and in connection with the foci suitable to the data supplied; the sea horizon or other direction being defined by a proper arrangement of posts and marks. In the night examination the apparatus is lighted up, generally with its own lamp, and the practical effect of the light is fully ascertained. The weight of the unworked cast glass in a complete revolving light of the first order is about two and a quarter tons, and in a complete fixed light about two tons, assuming the prisms to be eighteen and eight in each light.

The value of a first order fixed light with eighteen and eight prisms, with its accessories, is about £1,500; of a first order revolving light, about £2,000. The value of the lantern, which is made of gunmetal, wrought iron, and copper, and of the light room, made of cast iron lined with wood, is about £1,000 for the first order of lights; all other orders have a proportionate value. The dioptric lights constructed by Messrs. Chance since the year 1855 number about 150, of which more than one-third are sea lights of the first and second order. These have been furnished to all the leading maritime countries, except France, and to the British colonies. Some of the most remarkable are the Whalsey Skerries in the Shetland Islands, a revolving light, described by the Messrs. Stevenson as perhaps the most powerful in the world; the Lundy Island light, also revolving, distinguished by the late Royal Commission on Lights as visible at the greatest distance of all the reported lights at home and abroad; the fixed light at the Orme's Head in North Wales, and the fixed light at Europe Point, Gibraltar, to each of which there is added an arrangement for condensing, by means of vertical prisms, an arc of red light in a given direction, the result being, in the case of the Orme's Head, that the red light is distinctly visible at as great a distance as the white is, and in the case of Gibraltar, that still greater power and precision in the distribution of the light has been attained.

It might be supposed that a manufacture with such important objects, and on so extensive a scale, being, too, the only one of its kind in the country, would receive from our Government some degree of consideration and support; not, indeed, that kind of patronage which the French Government extent to Messieurs Sautter and Lepaute—a patronage as injurious to public interest as it is favourable to private aggrandisement—but the support and consideration founded solely upon the benefits accruing to the public service from the establishment of this manufacture as a national one, and upon the absolute merits of this apparatus as compared with all other apparatus for lighthouses.

The English house now competes with the French houses for the supply of the lights of the world, France excepted, and the world in general chooses the *best* apparatus without insisting that it shall also be the *cheapest.* But the Government of

Great Britain—as represented by the Board of Trade, which department has complete control over the expenditure of the lighthouse authorities—makes all considerations subordinate to the single one of *cost;* and practically treating a contract for one of the highest works of applied science as it would a contract for candles or for window glass, directs the acceptance of the lowest estimate, and hardly troubles itself with the consequences of such a policy.

On the other hand, the French Government, even with its new leanings to free trade, refrains carefully from asking the English house for estimates.

It results therefore that the French makers enjoy the power of supplying all the public lights of this country on the simple condition of a lower price, untrammelled by any stipulation as to quality, and unchecked by any similar power on the English side with regard to French lights. In a few rare cases indeed the English apparatus has been selected by the Board of Trade for its undeniable superiority, but with the condition that the price should be reduced to the French price.

Notwithstanding these difficulties, the English makers of dioptric lights are disposed to wait patiently until their apparatus shall receive as much practical appreciation from the Government of their own country as foreign Governments and as men of science everywhere already accord to it. They know that if they withdraw from the field it is little probable that another house will enter it, and that thus this fine but commercially almost profitless manufacture will be driven from the British shores which it has benefitted in no common degree.

The Messrs. Chance have already lost more than £20,000 in the enterprise, but they have erected more than a hundred lights, and these in after times will not be unworthily associated with their name.

BASALTIC STONE MANUFACTURE.

Although the employment of basalt in the manufacture of a peculiar kind of glass has now for many years been discontinued, it seems desirable to place on record a brief account of the circumstances under which the manufacture was undertaken, and the reasons which led to its abandonment.

At Rowley Regis, a village distant about two miles from Oldbury, five from Halesowen, and seven from Birmingham, a basaltic rock, known as "Rowley Rag," has for many years been quarried for mending roads and constructing pavements, purposes for which its hardness and durability render it particularly suitable. In 1851, Mr. Henry Adcock, C.E., who happened to be staying in the neighbourhood, conceived the idea of rendering this material available for manufacturing purposes by fusing it and casting it into moulds of the shape required. Sir James Hall, of Edinburgh, had demonstrated the fusibility of basalt at the commencement of the present century—(Transactions of the Royal Society of Edinburgh, 1805)—and a few experiments sufficed to show that it could be moulded without any great difficulty. On application to Mr. James Chance, a reverberatory furnace was placed at Mr. Adcock's disposal at the works of Messrs. Chance Brothers and Co., and further experiments were instituted with a view to testing the value of the invention. These being considered satisfactory, letters patent were obtained, and works were erected on a scale sufficiently large to accommodate what it was then thought would be an extensive department of the glass manufacture. A great variety of articles were manufactured—slabs for steps, window-heads and sills, string-courses, mantel-pieces, doorways, columns and capitals, besides a number of objects suitable for internal decoration, slabs for tables and sideboards, door plates and knobs, &c., &c. All of these articles were admirably adapted for the purpose they were intended to serve, but, unfortunately, the cost of production was too high for them to compete successfully with those manufactured on a less expensive system. The raw material, indeed, was sufficiently cheap, but the great heat required to fuse it, involving an equivalent expenditure of fuel—the vast variety of moulds required, each demanding the construction of a separate model, and very frequently available for only a single casting—together with the extreme intractability of the material after manufacture, all combined to render the production unprofitable in the majority of cases, and these causes, together with others which it is unnecessary to particularise, led at last to the discontinuance of the manufacture about three years after its establishment.

An analysis of the Rowley rag gives the following as its chemical constituents :—

Silex	46·0
Argil	16·0
Protoxide of Iron	19·5
Lime	11·0
Manganese	3·5
Volatile matter	4·0
	100·0

When cooled suddenly after fusion it is converted into black obsidian, or volcanic glass; but when allowed to cool slowly resumes its original crystalline basaltic structure, without any apparent difference beyond the obliteration of the lines of cleavage. When cast in a film so thin as to be carried away by an almost imperceptible movement of the air, the obsidian is nearly perfectly transparent, its opacity increasing with the thickness through shades of pale yellow, yellow, brown, and dark brown, to the intensest black. Like other glass it is capable of being drawn into fine filaments and spun, the general colour of a number of such filaments seen together being a rich golden brown. The various stages in the conversion from obsidian to basalt have been observed by interrupting the process of slow cooling at different times. A few crystals are first formed at considerable distances apart, which gradually increase in number and agglomerate as the cooling goes on, until at last the original stony structure is completely reproduced.

The processes employed in the manufacture were two. In the first, which was employed in the production of window-sills, pilasters, copings, &c., the basalt was fused in crucibles in a reverberatory furnace, and then cast in ordinary sand moulds, made red-hot previous to pouring the melted liquid into them, after which it was allowed to cool slowly in the oven in which it was cast.

In the second, the basalt was allowed to cool until it became plastic, and was then poured on a metal table and rolled in precisely the same manner as the ordinary rolled glass, in thicknesses varying from one-eighth of an inch to three-quarters of an inch, and in plates, some of which were as much as eight feet long by three feet eight inches wide.

The obsidian sheets thus formed could be cut with a diamond like ordinary glass, and were principally employed for roofing purposes, admirably withstanding the changes of the weather and the variations of the temperature, and being at the same time materially lighter than slates or tiles. They were also capable of being polished in precisely the same manner as plate glass, and thus adapted to a variety of ornamental purposes.

The specific gravities of ordinary glass and obsidian being nearly alike, although the materials will only commix mechanically and not chemically, it was found easily possible to produce a variegated appearance by stirring glass of various colours together with the fused obsidian, thus producing an exact imitation of various kinds of marble in appearance, but possessed of far greater durability. The obsidian, it was found, was acted on by hydrofluoric acid like other glass, and was thus capable of being ornamented by the ordinary processes of embossing. Beyond a few scattered specimens in private hands and at the works, but little now remains to be seen of the results achieved by this manufacture. One house at Handsworth still retains the window-heads and sills, string-courses, mantel-pieces, &c., cast from the Rowley rag, and somewhat similar examples are to be seen in a terrace near Aston Park, and another terrace in Wolverhampton. The best specimens, however, are to be seen in the Edgbaston Vestry Hall, a building in the Anglo-Norman style, the whole of the columns, window-pieces, doorways, and ornamental steps of which are cast in this material.

Such is a slight outline of the principal facts connected with the establishment of this singular manufacture. Financially a failure, it was mechanically eminently satisfactory, and there seems good ground to hope that under other circumstances at some future period it will again be the subject of commercial enterprise, and, in spite of the difficulties with which it is beset, be carried to a successful issue.

ON THE MANUFACTURE OF ALKALI AND ACIDS IN BIRMINGHAM AND THE NEIGHBOURHOOD.

By HENRY CHANCE, M.A.

THE manufacture of alkali is carried on to a considerable extent in the immediate neighbourhood of Birmingham, at three distinct works, decomposing in the aggregate about 12,000 tons of salt per annum. Of this material, which forms the basis of the manufacture in question, there is an abundant supply from the salt works of Stoke and Droitwich. Another important element, sulphur, is obtained from the black or coaly pyrites of Staffordshire and the adjoining counties.

This pyrites, however, being insufficient to meet the requirements of the manufacturers, is supplemented by importations of ore from other quarters. Cornwall, Ireland, Belgium, Spain, and Portugal, abound in pyrites, but the Portuguese ore (from Pomaron) is now generally preferred as combining hardness of grain with a high and uniform percentage of sulphur. This ore contains also a sufficiently large proportion of copper to render of value to the copper smelter the residue which is left after the extraction of the sulphur by the maker of alkali. Copper works have been recently erected at Oldbury for the treatment of this residual product.

The production of soda from salt without the previous conversion of the latter into sulphate of soda, and, failing this, the recovery of the sulphur which, after having served its purpose, is now thrown away in the form of "vatwaste," have long engaged the attention of practical chemists, but without any successful result.

But although the processes now in use for the manufacture of alkali are substantially the same as they were fifty years ago, various improvements have from time to time been introduced. They are, however, so ably detailed in the Newcastle Report of 1863 that anything beyond a passing allusion to them is unnecessary.

More recently the chief attention of the alkali manufacturer has been directed to effecting an entire condensation of the hydrochloric acid gas, the production of which is a necessary part of his process.

Following in the steps of Mr. Gossage, and stimulated by the Alkali Works Regulation Bill of 1863, the alkali makers of the United Kingdom have so completely effected the condensation of this gas that the inspector in his first report is able to state that whereas for some time after the inspection had begun 40 per cent. of the gas was in some cases allowed to escape, while 16 per cent. was a very common amount, in February, 1865, every alkali works was condensing more than the amount required by the Act, while twenty-six works were condensing 100 per cent.

This condensation leads to the production of one of the most important acids of commerce, hydrochloric or muriatic acid. It is used largely in the manufacture of bleaching powder, chlorate of potash, muriate of ammonia, bicarbonate of soda, and various chlorides.

Mention has already been made of pyrites as one of the important elements in the manufacture of alkali. By roasting this material the alkali maker obtains a supply of sulphuric acid for the decomposition of his salt, but in addition to the quantity thus consumed, there is a very large production of this acid in Birmingham and the adjoining districts for various manufacturing purposes. Sulphuric acid made from pyrites always contains a certain percentage of arsenic, and although the amount of this impurity may be diminished, no method has yet been discovered of entirely eliminating it. Whenever, therefore, the presence of arsenic would be objectionable, silician sulphur is substituted for pyrites in the manufacture of this acid.

Sulphuric acid is employed extensively in this district in the manufacture of superphosphate of lime, sulphate of ammonia, phosphorus, the preparation of metals, and also as an agent in the production of nitric acid. The following is an approximate estimate of the principal products of the alkali works of Messrs. T. Adkins and Co., Messrs. Chance Brothers and Co., and Mr. W. Hunt:—

Annual produce of Soda Crystals . .	12,000	tons.
,, ,, Brown Oil of Vitriol	20,000	,,
,, ,, Bleaching Powder .	300	,,
,, ,, Muriatic Acid . .	10,000	,,
Annual consumption of Coal	40,000	,,
,, ,, Pyrites . . .	12,000	,,

ON THE MANUFACTURE OF SOAP.

BY HENRY ADKINS.

BIRMINGHAM and the surrounding districts obtain their chief supply of hard soap from the local manufactories, also from London, Liverpool, Warrington, and Bristol. Formerly soap making was carried on in most of the small towns of the kingdom, and but little was furnished by the seaport towns.

The improvements, however, introduced in the processes of manufacture by the larger makers in the seaport towns, together with the facilities of transit by means of canals and railways, have greatly diminished the number of makers in the interior parts of the country. About the commencement of the present century, the principal hard soaps in use were—white soap, consisting of soda and tallow; mottled soap, consisting of soda, tallow, and kitchen grease; and brown soap, consisting of soda, palm oil, and resin. The palm oil in its natural state being of a red colour, against which much prejudice existed, it was partially bleached by means of nitric acid. An improved method of bleaching was discovered by Mr. Boyle, who first introduced it at the works of Messrs. Blair, of Tipton. It consisted of simply heating the oil to a temperature of 430 degrees. This improvement was in its turn superseded by boiling by steam and exposing a large surface of the oil to the action of the air. Finally, a still more effectual method of bleaching was discovered, and is now generally adopted. It is accomplished by treating the oil with bichromate of potash and hydrochloric acid. The superior quality of soap yielded by this process greatly diminished the consumption of those kinds previously in use, and it became the staple article of demand in the Northern and Midland Counties. In London this kind of soap was objected to from its peculiar odour, and one made of tallow and resin was generally preferred. Since the repeal of the duty on soap, which occasioned a reduction to the consumer of more than 1½*d.* per lb., the tallow and resin soaps just referred to have had a largely increased consumption. About sixteen varieties are now manufactured, a blue mottled soap, made of palm oil and cocoa-nut oil, lately introduced, being much in request in this district. From time to time considerable improvements in the process of soap making have taken place, one of the most important of which was introduced about twenty years ago, being the application of steam to the boiling of soap, in lieu of the old method of boiling by an open fire. Another improvement consisted of an alteration in the mode of causticising the alkali. This is now done by boiling by steam a mixture of lime and carbonate of sodium. Previously the alkali was interstratified with lime in a vat, and the caustic soda separated by filtration.

A considerable saving has been effected in the cost of the production of the alkali used in soap making, by a process introduced by Mr. Gossage, of Widness. The crude soda liquor obtained from the decomposed sulphate of sodium contained a portion of sulphide of sodium, which was objectionable on account of its communicating a blueish tint to the saponified fat. This defect, formerly obviated by evaporating the liquors and heating the residue in a reverberatory furnace, is now remedied by warming the liquors and passing them down through a tower filled with coke, through which a current of air is passing in an opposite direction.

Mr. Gossage also uses the weak caustic lees in his steam boilers instead of water, thus effecting by one process the generation of steam and the concentration of the lees.

With respect to the consumption of hard soap in Great Britain and Ireland, it is computed to amount to rather more than 100,000 tons per annum. Estimating the population at 30,000,000, this would give seven and a half pounds for each person.

The quantity produced in Birmingham and its immediate neighbourhood probably does not exceed 2,500 tons per annum.

Hard soap is made by boiling oil and tallow, or these materials mixed with resin, with a solution of caustic soda. To prepare this solution, which is called lees, a quantity of carbonate of sodium is first dissolved in a vat with boiling water, the solution is then syphoned off into another vat of large dimensions, where it is mixed with caustic lime, and the density reduced by water to twenty degrees of Twaddell's hydrometer. This reduction of density is found greatly to facilitate the causticisation of the lees. The mixture is boiled by free steam for an hour or more, and when the solution is found, by testing, to be sufficiently caustic, the boiling is discontinued, the lime deposits itself in the vat, and the clear lee is removed by a pump into a reservoir. It will be found when cold to have a density of 24 degrees, and to contain about 7·85 per cent of caustic soda. The pans or "coppers" in which soap is made are large cylinders of wrought iron, from 15 to 20 feet in diameter, and from 12 to 15 feet in depth. The bottom is formed by a wide flange, in the centre of which there is a cup, 3 feet in diameter, and 2½ feet in depth, to receive the pump and a coil of pipes for boiling the copper by steam. This coil has no perforations, and is intended to heat the lee, or soap, by surface action only. Another coil of pipes, with perforations, is laid upon the flange for the purpose of boiling by free steam.

The process of soap boiling is commenced by placing in the copper from twelve to fifteen tons of tallow, and adding a quantity of lee from the reservoir. The free steam is then admitted, and the materials brought into a state of ebullition. When it is found by tasting that the lee has lost its sharpness, another addition of lee is made, and this operation is repeated till the copper is full. The soda of the lee is now combined with the tallow, the product being in a state of close union with the water. To separate the latter, a quantity of common salt is added, which causes the partially saponified tallow to rise to the surface. The spent lee, which contains the glycerine previously in combination with the tallow, together with the common salt, carbonate and sulphate of sodium, and some other impurities, is now removed. This is usually done by a pump, though this method is troublesome and unnecessary. By the ninth section of the Act of Parliament which regulated the process of soap making till a late period, it was forbidden to remove the lees or soap from the copper by any other means than by a "moveable pump and open shute, or by pails and ladles only." It is difficult for anyone unacquained with the trade to estimate the amount of inconvenience occasioned by such a regulation, and several makers finding it impossible to adapt the apparatus in use during the existence of the excise restrictions to modern improvements have recently erected new manufactories. The coppers were formerly placed in the basement of the building, and the soap had to be carried in pails to a room on the same or a higher level. By reversing this order, and placing the coppers in the upper story, it is easy to remove either the lees or soap by running it off through a tap.

After the removal of the spent lee, a further quantity of lee is added, and the process above described is repeated till the whole of the tallow is converted into soap. This is known to be accomplished when after a long boiling the causticity of the lee is maintained, and the soap is no longer greasy to the touch, but breaks into scales or layers when pressed between the fingers. The partially spent lee is now removed, and such a quantity of water added as will bring the soap into a perfectly fluid state. When this is found to be effected, lee is slowly added till the soap begins to part from the weak lee. The use of free steam which has been hitherto employed is discontinued, and the copper is made to boil by the close coil. As the evaparation proceeds, a light froth or head gradually covers the surface of the soap, which is now a mass of small grains, and the process is complete. The supply of steam being stopped, the whole is allowed to rest for twenty-four hours, during which time the lee subsides. The soap is now removed by a ladle, and placed in moulds or frames made either of wood or iron. The wooden moulds are made by placing a series of wooden frames one upon another, each frame (technically called a lift) being five inches deep, forty-five inches long, and fifteen inches wide, resembling a box without top or bottom. The whole are bound together and secured to an iron bottom by means of iron bars, so as to form a vat of the depth required, usually about sixty inches. The next operation upon the soap is called "crutching," and consists of stirring it with an implement called a "crutch," with the handle downwards, the effect being to give the soap an uniform and smooth appearance. The product is called white or curd soap. It is found by analysis to contain:—

Soda	6·96
Fatty Acids	61·63
Water	30·30
Iron, Alumina, Chloride, and Sulphate of Sodium	1·11
	100·00

When the soap has remained in the frames for about a week, and has become hard, these are removed. It is then cut into layers by a wire, and divided into bars by a machine. After twelve hours it is ready for sale.

Primrose soap is made by saponifying the tallow in the same manner as for white soap, and then adding a quantity of fine resin equal in weight to one-fourth of the tallow used, and continuing the operations in the manner before described. But as a soap containing resin, if framed in a state of curd, would be opaque and objectionable in appearance and colour, it is necessary to submit it to a further operation called "fitting." This process is effected by removing the lees from the bottom of the copper by a pump, and adding a quantity of water amounting to about five per cent. of the weight of the soap. The addition of water brings the soap into a perfectly liquid state, and after well boiling the steam is turned off, and the whole left to settle for forty-eight hours. The water does not continue mixed with the whole of the soap, but combining with a portion only (generally about twenty-five per cent.) sinks to the bottom of the copper, carrying with it the excess of alkali, together with the earthy and metallic salts and other impurities which may happen to be present. This deposit is called "nigre."

The supernatant soap is now transparent and of a lemon colour, containing by analysis:—

Resinous and Fatty Acids	62·00
Soda	6·96
Water	30·50
Chloride and Sulphate of Sodium .	0·54
	100·00

It is worthy of remark that a loss of resin occurs during its conversion into soap equivalent to forty per cent., and no method has been devised by which this loss can be remedied, nor has the subject received that consideration which it deserves.

EXTRA PALE SOAP.

The nigre remaining after the removal of the primrose soap is of a dark colour, and cannot be used again for the manufacture of the same kind of soap. It is, therefore, usually transferred to another copper, where it is mixed with a quantity of tallow and saponified as before. This addition partially obviates the defect, but, as the soap produced is not equal in colour to primrose soap, it is sold at a lower price under the name of extra pale.

TALLOW CROWN.

The nigre from the extra pale soap is made into tallow crown by adding a quantity of brine, and boiling to a curd.

The brine is then removed by the pump and the soap fitted in the usual manner, no fresh material being employed. The nigre is returned to the succeeding boil of tallow crown. This soap, being much inferior in colour to extra pale, is sold at a lower price.

Various causes have been assigned for this deterioration in colour; by some it has been attributed to the presence of iron and alumina derived from the lees, but as this change in colour does not take place in a soap made without resin, it cannot be due to the mere *presence* of the metals, or to their combination with tallow. Others have thought that a much larger quantity of resin was present in the nigre than in the soap, and that this might cause the degradation in the colour, but as the tint is brown while the colour produced by resin is yellow, this explanation is not satisfactory. It may possibly arise from the action of the alkali upon some constituent of the resin, or from a combination taking place between the resin and the iron and alumina. When a cheap tallow soap is required, it is made by the addition of weak brine in the frames.

PALM OIL.

Palm oil in its natural state is of a red colour, which it is necessary to remove. This is effected by first melting the oil in a vat, and allowing it to stand for some time to deposit any impurity which may be present. It is then transferred to another vessel, and allowed to cool to 90 degrees Fahrenheit. To each ton of oil, 20 lbs. of bichromate of potash, dissolved, and 56 lbs. of hydrochloric acid, of 28 degrees Twaddell's hydrometer, are added; the whole is well stirred, and in about half-an-hour is found to be nearly free from colour.

Ten gallons of boiling water is now added, and the whole, after well stirring, is left to subside. The sesquichloride of chromium and chloride of potassium are found in solution in water at the bottom of the vat, and the oil is ready for use.

PALM OIL SOAP.

Crown pale is made from chronic bleached palm oil and fine resin, in the same manner as primrose soap.

Mottled brown is made from palm oil bleached by nitric acid. This process is less expensive than the method of bleaching by bichromate of potash, and as an inferior and cheap resin is used, the soap is sold at a lower price than crown pale.

Third pale was at one time more largely consumed in the midland counties than any other variety of soap. Since the repeal of the duty, in 1853, better kinds have been substituted at a lower price, and third pale is now but little used. It is made by adding 3½ cwt. of weak brine to 16½ cwt. of crown pale. This addition is made in the frames.

Common yellow is made by adding 8 cwt. of weak brine to 12 cwt. of mottled brown soap in the frames. The effect of chloride of sodium and many other salts upon soap is curious. If an attempt be made to unite the latter with water, even at a boiling temperature, an immediate stiffening of the mixture takes place, and the whole becomes nearly solid, but if to this mixture a few pounds of common salt be added it will be brought to a state of perfect fluidity, and will not resume its former consistence until the temperature is reduced 130 degrees Fahrenheit. The production of a state of fluidity, however, is not the only result obtained by brine. It has the property of hardening soap to an extraordinary degree, even though a very small quantity be added, the effect of a few ounces of strong brine upon a ton of soap being quite perceptible.

MOTTLED SOAPS.

First mottled is made in the same manner as white soap, the materials employed being tallow and kitchen stuff. The mottling is not produced by any artificial addition, but is, in fact, the nigre or metallic soap, which distributes itself in spots when the soap is allowed to undergo a semi-crystallisation by gradual cooling in large frames. In yellow soaps, the nigre is deposited in the coppers by the process of fitting, and in white soap is prevented from separating by rapid cooling. Popular prejudice, however, is in favour of this appearance in this description of soap, which was at one time a guarantee of genuineness, no method being known by which a mottle could be introduced into an adulterated soap. Since the repeal of the duty, many varieties of watered mottled have been manufactured and largely sold, the genuine mottled soaps being in this locality almost superseded by the adulterated ones.

A very hard and beautifully mottled soap was found, on analysis, to contain—

Fatty Acids	18·66
Water	62·50
Soda	4·24
Sulphate of Sodium	0·67
Chloride of Sodium	10·31
Silicic Acid	0·30
Iron and Alumina	0·57
Organic matter and Glycerine	2·75
	100·00

Whereas a genuine mottled soap contains—

Fatty Acids	62·00
Water	30·00
Soda	7·00
Iron, Alumina, Chloride, and Sulphate of Sodium	1·00
	100·00

Crown mottled differs from first mottled in being made from bone grease only, and has the same percentage composition. Blue mottled, which is of recent introduction, is largely used in Birmingham and the surrounding districts, Its manufacture, which is of German orign, was first introduced into England by Mr. Kottula, superintendent of the works of Messrs. Blake and Maxwell, of Liverpool, who obtained a patent for the invention.

Messrs. Palmer, of London, some time afterwards commenced the manufacture of this kind of soap, and contested the validity of the patent in a court of law. It was well known in the trade that the patent was invalid, and in one case a manufacturer submitted to work under a license for which a large sum was paid rather than incur the expense of a legal contest. It was proved upon the trial that a description of the process had been published in a book written by a Mr. Kurten, and that soap had been made in London from directions contained therein. The patent was therefore declared to be invalid. Previous to the trial, the licenses under Kottula's patent were threatened with legal proceedings by another patentee, who asserted that Kottula's patent was an infringement upon one previously granted to him. The evidence produced upon the trial was so conclusive that no further steps were taken.

The process by which blue mottled soap is made is as follows:—A quantity of palm oil, bleached by bichromate of potash, is saponified and boiled to a curd in the usual manner. The curd is then transferred to another copper, and a quantity of cocoa-nut oil, equal in weight to half the palm oil, is added, and saponified with twice its weight of lees at 34 degrees of density (Twaddell's Hydrometer). Some ultramarine blue is then added, and the soap, which is not in a state of curd, but in combination with all the water of the lees last used, is transferred to the frames. The ultramarine in cooling separates from the soap, and produces the mottled appearance. This soap contains, by analysis—

Fatty Acids	46·13
Soda	6·85
Water	43·00
Glycerine, Iron, Alumina, Chloride, and Sulphate of Sodium	4·02
	100·00

It should be borne in mind that the manufacturers do not derive any advantage from the practice of adulteration, which is adopted to enable the retailer to accommodate his price to the requirements of his customers.

The chief manufacturers of soap in this district are Messrs. T. Adkins and Co., Smethwick. There are also Messrs. Harvey and Co., Smethwick; and G. Smithson, Smallbrook Street, Birmingham.

ON THE MANUFACTURE OF RED LEAD.

BY HENRY ADKINS.

RED LEAD, which forms one of the principal ingredients in the composition of flint glass, has been for a considerable period extensively manufactured in Birmingham and several of the adjacent towns. The invention of flint glass, which is of English origin, arose out of the difficulties experienced in the use of coal as fuel. To protect the glass from the injurious effects of the smoke produced by the imperfect combustion of this substance, it was found necessary to make use of covered pots, which increased the difficulty of fluxing the materials to such an extent as to render necessary the addition of some other ingredient to increase the fusibility of the glass. This object was accomplished by the use of oxide of lead. The brilliancy of the glass thus produced, the facility with which it could be worked by the glassblower, on account of its easy fusibility, and the readiness with which it could be ornamented by the glasscutter, on account of its softness, have caused the continuance of its use, although the obstacles which at first impeded the manufacture of glass without lead have since been overcome, and a flint glass, containing but a small quantity of lead, is now extensively manufactured at Newcastle-on-Tyne.

The principal supply of glassmakers' red lead was at one time obtained from Derbyshire. The quality was inferior, and imparted to the glass an objectionable shade of colour, known in the trade as the Derby blue. This defect was afterwards remedied by Messrs. Blair and Stephenson, of Tipton, who secured for many years a monopoly of the supply of the finest quality.

About the year 1817, Mr. Boyle, who had been for some time manager of the works of the above-named firm, entered into partnership with Messrs. Adkins and Nock, of Smethwick, who a few years later commenced the manufacture of glassmakers' red lead, and, on the retirement of Messrs. Stephenson and Co. from the trade, became for some years the principal makers.

In course of time several new firms entered into the trade, which is now extensively carried on in many parts of the country; nevertheless, the manufacturers of the midland district still maintain their pre-eminence, and the principal supply of the best quality consumed in the United Kingdom is produced in the above-named locality.

The process of manufacture is as follows:—A quantity of lead is placed on the bed of a reverberatory furnace, of a peculiar construction, and exposed to a high temperature, while the metal is constantly agitated by striking it upon the surface with a rake. A combination takes place between the lead and the oxygen of the atmosphere, and the oxide of lead thus formed is removed by the rake to the back of the furnace. These operations are continued during a period of twelve hours, at the expiration of which time any metallic lead which may have failed to have become oxydised is removed, and the remaining oxide is exposed, by constant turning, to the action of the air, and, at the termination of a further period of twelve hours, is withdrawn from the furnace. The substance thus produced, which is called litharge, is now ground into an impalpable powder with water, and flows into a series of tubs, where it is kept in a state of agitation by a revolving stirrer, furnished with arms. The particles of metal which have escaped oxidation, having a greater specific gravity than the oxide, remain in the stirring tubs, while the oxide of lead passes on into another series of tubs, where it subsides from the water. The supernatent water is afterwards removed by a syphon, and the moist litharge transferred to a reverberatory furnace, where it is exposed to the combined action of a low temperature and a current of air for a period of twenty-four hours. During this process, the litharge enters into combination with a further quantity of oxygen, and minium, or red lead, is produced. The manufacture is completed by passing the substance through a revolving cylinder of wire gauze, to remove any lumps that may have been formed, or any large particles of foreign matter with which it may have become intermixed during the previous operations.

The principal manufacturers in this district are Messrs. T. Adkins and Co., Smethwick; Messrs. Lloyd and Co., Smethwick; and Messrs. Burr Brothers, Shrewsbury.

THE COVENTRY RIBBON AND WATCH TRADES.

The striking revolution which has taken place in the ribbon trade during the last few years might well entitle Coventry to a place in our review, even if it had no other claims, as the centre of two important manufactures within the Birmingham district. Happily, the cry of "Coventry distress," so importunately raised and so nobly responded to a few years ago, is now completely hushed in the silence of prosperity. Masters and men are no longer at feud, and commerce, released from its restrictions, has extended far beyond its ancient limits. A detailed history of the revolution thus accomplished would be here out of place; but the importance of the circumstances connected with it both to the merchant and the political economist, and the fact that they have been very generally misunderstood, will, it is hoped, be a sufficient justification for placing them on record at some considerable length.

For nearly five centuries Coventry has been the seat of certain departments of textile manufacture. In 1436 it had already become famous for its woollen cloth caps and bonnets, and early in the next century, for the blue thread so long celebrated as "Coventry true blue," the superior colour of which was attributed to the purity of the water of the Sherborne employed in the dyeing. This branch of manufacture seems, however, to have been neglected after 1581, when woollen and broad cloths became and continued to be the staple manufacture till the destruction of the Turkey trade, in 1694. About the commencement of the last century, silk throwing and ribbon weaving were introduced, and by degrees almost entirely superseded the manufacture of striped and mixed tammies, camlets, shalloons, and calimancoes, which had arisen on the ruins of the former trade. The origin of watchmaking in Coventry is enveloped in considerable obscurity, but it seems to have been established on a small scale previous to 1760.

The ribbon and watch trades are at the present time still the most important of the industries of Coventry, but the manufactures of elastics, cambric frillings, gimp trimmings, Bradford goods, &c., have within the last few years been successfully established, and bid fair to rival the prosperity of the earlier trades. Ornamental metal-work, of a superior quality, has also now for several years been a branch of manufacture industriously prosecuted.

THE RIBBON TRADE.*

More than thirteen centuries have elapsed since two Persian missionaries, encouraged by the gifts and promises of Justinian, transported from the celestial empire into Byzantium the eggs from which all the generations of European silkworms have descended, concealed, like the fire of Prometheus, in a hollow cane. Before long, Venetian commerce introduced the merchandise of the Greek empire into the markets of Western Europe, and furnished the Gothic monarchs with Byzantine fabrics not inferior to those which the "peaceful Cathaians" had supplied of old to the munificence of Alexander, the avarice of Tiberius, and the effeminacy of Elagabalus. Our Saxon kings were not the last to reap the benefits of the first growth of modern civilisation. As early as 790, Charlemagne presented to the Mercian Offa two silken vests as a token of imperial amity from "the most powerful of the kings of the East" to "the most powerful of the kings of the West," and thus, not improbably, brought for the first time under the notice of the citizens of Coventry the material in the manufacture of which they were in after days to achieve celebrity. It was not, however, until after the lapse of nearly a thousand years that the silk manufacture took root in Coventry. Among those dispersed by the revocation of the Edict of Nantes were a large number of ribbon weavers from Tours and Lyons, the silk trade of the former city being totally extinguished by the measure. From the number of French terms still in use in the trade, it seems highly probable that some of these weavers found their way to Coventry, and were the first workmen employed when the ribbon manufacture was established by Mr. Bird, either just at the close of the seventeenth or very early in the eighteenth century. At the time of its introduction, the importation of French and Italian silks into this country was prohibited; but after the Treaty of Utrecht, in 1713, a high duty was substituted for the previous total exclusion. In 1765, however, the prohibitory system was reintroduced, and lasted through the obstructive reign of George III. down to 1824.

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* A brief account of the principal processes and terms employed in the ribbon manufacture will be found useful to the uninitiated reader. "Throwing" silk is preparing it for the weaver by converting it into three forms, known as "singles," "tram," and "organzine." "Singles" is formed by simply twisting the filaments of raw silk to give firmness to their texture. "Tram" is formed by twisting together two or more filaments of "singles." The "weft" or "shoot" of the ribbon is commonly formed of "tram." "Organzine," principally used for the "warp" or long threads of the ribbon, is formed by twisting together two or more strands of singles or tram in such a manner that the twist of the combined thread is in the opposite direction to the twist given to the separate strands. This process prevents it untwisting. Silk thus "thrown" is called "hard" silk, and must be boiled before dyeing, in order to discharge the gum which forms part of the secretion of the silkworm. To "denier" silk is to ascertain the exact weight of a certain length of filament. The length usually measured is two bracci of Milan, equal to 520 English yards. The weight of this length is then ascertained in deniers, each denier being ·825 of an English grain. Bengal and some other silks are deniered in what is called the English way, *i.e.*, by ascertaining the weight of 1,000 yards in drams. The various widths of ribbons are expressed in *pence*, usually written "dy." Thus an "eightpenny" or "8 dy" ribbon is a ribbon an inch wide; a "fortypenny" ribbon however, is not precisely five inches wide, and the number of "pence" denoting the width is somewhat arbitrarily arranged. It is difficult to account for the use of this peculiar system of measurement. The following are some of the commonest names of the various kind of ribbon:—"Sarsenet," plain ribbon under 12 dy, or one and seven-twelfth inches. "Lustring," plain ribbon above 12 dy, generally stouter than sarsenet. "Gauze" ribbon is made of "hard" twisted marabout silk. "China" is the same, with plain silk ("ground") or satin stripes. "Loves" are inferior gauzes, of which the "shoot" is made of "hard-dyed" singles. "Pads" or "Petershams" are thick ribbons generally used for the waist; they are commonly made of cotton, with silk on the outside. "Ferrets" are ribbons shot with cotton. "Chiné" ribbons are made by printing or painting a pattern on the warp, which is afterwards woven in. "Orientals" are ribbons with satin stripes. Nearly all the ribbons now manufactured are "orientals," with a narrow satin strip along the edge, which is generally corded. "Blocking" is winding the ribbon on wooden blocks, and preparing it for sale. The method of blocking now in use has only very lately been introduced at Coventry. It consists in winding the ribbon on the wooden roller with strips of paper of the same width between.

During the earlier portion of this period, the history of the trade at Coventry is very obscure. For many years the weaving was performed exclusively by single hand looms, making only one ribbon at a time. The "plain engine," or Dutch loom, making a number of ribbons at once, was first introduced about 1770, but its general employment dates apparently only from the commencement of the present century. Up to 1812, the trade was conducted on the "undertaking" system, the manufacturer providing the silk, dyed in the hank, and the "undertaker" providing the looms and other machinery. The operations were generally conducted by the "undertaker" himself and the members of his family, assisted by apprentices and "journey hands." The finished article was returned to the manufacturer, who paid the undertaker a well understood price for its production, according to the time and skill required. Two-thirds of the price thus received went, under this system, to the journey hand weaver for his labour in filling the shoot, picking up the warp, and weaving and picking the ribbon, the remaining one-third being retained by the undertaker as an equivalent for his labour, time, responsibility in procuring work, finding machinery and shop-room, winding of warp and shoot, warping, assisting the journey hands in putting in new patterns, and general superintendence. Almost every journey hand, male or female, had served an apprenticeship to the trade, the former of seven, the latter from five to seven years. Under this system the only "strike" ever known was occasioned by a journey hand wishing his wife to be employed on one of the Dutch looms. The strike was successful, and no women were permitted to weave in any but the old single hand looms.

So long as French ribbons were admitted into this country, the Coventry manufacturers under the spur of competition maintained a very high degree of excellence, which, however, seems to have been better appreciated by the manufacturers and merchants than by the English public. From 1765, when the importation of French ribbons was again prohibited, a marked decadence is perceptible both in quality and taste, and it was not till after 1824, when foreign competition was again partially permitted, that the Coventry fabrics regained their former standard. The period at which taste in ribbons seems to have been at the lowest ebb, seems to correspond almost precisely with that of the war with France, during which smuggling, the necessary consequence and, to some extent, the palliative of the evils of protection, was attended with extraordinary difficulties. The products of this period, in fact, betoken a total shipwreck of the art of design. Many of the ribbons of this period, almost the whole of which were narrow widths, 8 dy and under, were printed or embossed; the mourning ribbons, for instance, manufactured on the death of the Princess Amelia, in 1810, displaying a barbaric pattern printed in opaque white on a white ground. A similar style had shared with equally inelegant brocades the fashion of the previous year; these, again, having partly for a time superseded the orris, terry, and velvet ribbons of 1808. The triumphs of debased ornamentation are to be found, however, in the silken records of the jubilee year 1809, when George III. entered on the fiftieth year of his reign, and of the numerous naval victories under Duncan and Nelson, from 1802 onwards. In these truly astonishing productions, many of which are still preserved in the pattern books of the period, and in the hands of collectors, we find amorphous silhouettes of ships and anchors with mottoes, all printed in black on various coloured grounds, testifying at once the patriotism and the barbarism of the times, while a few ribbons, scarcely superior in design, but redeemed to some extent by the figures being made with the shuttle, either in silk or tinsel, then a favourite material, instead of being printed, manifest at the same time the possession of a skill in weaving which certainly deserved to be turned to better account. The prices of silks and ribbons naturally fluctuated greatly during this period. In 1808, owing to the closing of the Italian ports by Napoleon, fine Italian warp stood in February at 70*s.* per lb., and in April at 100*s.* In August it fell to from 60*s.* to 63*s.*, falling again in October to 59*s.* and at the beginning of the next year to 53*s.*, other descriptions rising and falling in proportion.

From 1812, the history of the trade is one of continually recurring revolution. For some years the demand for ribbons had been decreasing; the trade languished, and the weavers were plunged in destitution. Suddenly, by an unaccountable change in the prevailing fashion, an extraordinary demand arose for ribbons with large pearl edges, and a golden age at last dawned on the distressed weaver, still fondly remembered by the old hands as the "big pearl time." The watch trade at the same period was in a state of great depression, and popular tradition still tells how on one occasion a placard was issued advertising for fifty distressed watchmakers to come and shell peas for the weavers. The demand for pearl-edged ribbons thus created was far greater than the supply, and wages rose to an unprecedented height. In the previous years of depression the weavers had enlisted in great numbers, and the amount of skilled labour required was not to be at once obtained. Ribbon, however, with large pearl edges must be had. If skilled labour was not to be procured, unskilled must be employed. The quantity was the first, the quality a merely secondary consideration. The undertakers, in order to meet the pressure on their resources, broke through the system of seven years' apprenticeships, and employed a number of country hands, called "half-pay apprentices," upon shorter terms, the learners living away from the undertaker's home, and receiving half the price obtained from the manufacturer for their work as wages. The manufacturers also broke through their old system of all paying the same price for the same kind of ribbon, and began to outbid each other in order to get their commissions executed. The weavers petitioned the manufacturers for a recognised uniform advance throughout the trade. The manufacturers responded by uniting and drawing up the first printed and published list of prices known in the trade, on February 13, 1813. From this time to the autumn of 1815, the demand continued unabated; but almost the moment that the general peace was concluded, it ceased as suddenly as it had arisen, and the whole trade collapsed in confusion and distress, materially aggravated by the simultaneous overstocking of the labour market in consequence of the disbanding of the army. It was a time of failure and panic. The larger manufacturers were for the most part heavily indebted to the silk brokers, and a general re-arrangement of the trade ensued, which transferred the business of distributing the manufactured goods from the hands of the manufacturers into those of the large silk warehousemen in London. The latter, naturally, cared only to buy in the cheapest market, and thus the channels of trade were opened to the smaller capitalists, who had previously traded at a greater disadvantage as compared with their wealthier rivals. These small capitalists, by working themselves and employing their families, were able to produce goods at a cheaper rate than their competitors, and the large manufacturers soon discovered that their only course was to employ machinery, and to take upon themselves the duties of the "undertaker." Machinery was accordingly purchased; the "throwing" was frequently done on the premises; hand-loom factories were built, improved engine looms procured, and the weaving performed by journey hands under the superintendence of a foreman. In a trade, however, liable to such sudden fluctuations, it was too dangerous to embark in such an outlay as would provide machinery for executing the whole of the orders that might be received. The best and steadiest journey hands, therefore, who did not possess looms, were enabled to purchase them, and supplied with work from the warehouses with the preparatory processes already in a great measure performed. This was called the "journey hand system," and the weavers, known at the present day as "out-door weavers," were called "first hand" or "out-door journey hands." As this system became more and more largely developed, the old "undertaking system" declined, and has now long been almost obsolete, except in some minor departments of the trade. The system of half-pay apprenticeships was still continued, and the trade was thrown open to women as well as men.

The number of returned soldiers, in addition to those who had been attracted from the agricultural districts during the "big pearl time," still kept the supply of labour above the demand, and prices continued their downward progress for some years in spite of the establishment of a "Weavers'

Provident Union," in 1815, which made repeated efforts to resist the tendency. One result of their agitation was a meeting between three deputies of the weavers and three of the manufacturers, in September, 1816, when another list of prices was agreed on, followed by the success usually attendant on endeavours to reverse the action of natural laws. A movement was then set on foot to put a stop to the half-pay apprenticeship system by Act of Parliament, and to enforce the list by allowing magistrates to punish infractions of it by fine or imprisonment—in fact, to extend the Spitalfields' Act, then in operation, to Coventry. Most of the manufacturers joined in the movement, and an active agitation on the subject was kept alive both by masters and men. Parliament, however, wisely declined to interfere in the direction desired, but appointed a committee to enquire into the general condition of the silk trade, and it is to the evidence adduced before this committee that we owe the repeal of the Spitalfields' Act itself, in 1824. But, though the agitation failed to obtain the support of the Legislature, it was still able at least partially to obtain its objects by a somewhat singular application of Lynch-law known as "donkeying," *i.e.*, setting the offender astride an ass with his face to the tail, and making him ride in progress through the main streets of the city, a device which, assisted by a strong feeling on the part both of employers and employed, maintained for some time a tolerably general observance of the list. Still, in spite of every effort, infringements of the list had become so common before 1819, that in that year a general strike took place. A meeting of manufacturers was held, and a new list was published on August 17, the manufacturers and weavers uniting and subscribing a large sum for its protection, which by the following spring had increased to no less than £16,000. This organisation, by the combination laws then in force, was illegal, and an adverse verdict at Warwick Assizes was the death-blow of the Association, the whole of the remaining funds of which were handed over to the Street Commissioners for paving the city. Another list, published in 1822, brought on another general strike, followed by the establishment of the list of 1819, which was partially observed till 1824, when it was abandoned under the terrors of French competition.

In 1824, the high duty on raw silk was reduced to one merely nominal. On thrown silk it was reduced by one-half, and the admission of foreign goods was made legal after July 5, 1826, although it was practically deferred for some time longer. The year 1826 was one of disastrous commercial collapse after two years of over-speculation and over-production. A new list for the "plain engine" trade was again agreed on, but it was found impossible to maintain it in the teeth of French competition, and it was again abandoned in 1829. In 1831, the manufacturers announced another reduction of prices, which was again followed by a general strike. Mr. Beck had just completed a new factory, not on a very extensive scale, but for the first time introducing steam as the motive power. During the strike it was burnt to the ground by some of the weavers, and the employment of steam-power was deferred for the next five years. A meeting between the masters and men was held, and shortly afterwards a Manufacturers' Association was formed. Three lists, regulating the prices for work in the plain engine, the single hand, and the Jacquard looms, were drawn up, of which the first was the only one observed. The second was almost immediately broken through, the third was abandoned, and in 1834 the Association itself was broken up. In this year another strike was followed by another list, which was again broken through, and followed by another strike. In 1835 the last list ever established was promulgated, and continued to form the acknowledged basis of prices in the plain engine weaving till the collapse of the trade in 1860, the Jacquard and single hand weavers never having enjoyed the very questionable benefit of a list since 1832.

The burning of Mr. Beck's factory, in 1831, was followed by its natural results. Steam power was applied to the looms at Leek, Congleton, and Derby, and the Coventry operatives began to feel that foreign competition was by no means so dangerous as the one they had created for themselves nearer home. A company was established and a new steam factory erected, but owing to some disagreement among the partners a considerable delay occurred before operations were actually commenced. It was afterwards started in other hands, and individual manufacturers were not slow in following the example, a Mr. Day rendering himself particularly unpopular by introducing in his factory not only the employment of steam power, but the system of weekly wages, and sundry other innovations in the management of the looms.

In 1832, a Committee of the House of Commons was appointed to enquire into the condition of the silk manufactures of the country. The manufacturers declaimed fiercely against the importation of French goods, and declared that nothing short of absolute prohibition and stricter customs' regulations could produce any effect on the obstinate preference of English ladies for French ribbons, or save the producers of the English goods from immediate ruin. The committee listened with composure to their statements and did nothing. The next year and the next the manufacturers reiterated their grievances, but Parliament still maintained its judicious obstinacy. In 1832, it was confidently asserted that steam could never be profitably applied to the manufacture of ribbon, and even so late as 1838 the highest authorities in the trade decided that a good ribbon could never be made by steam so economically as by hand. Events proved that the highest authorities in the trade had yet to learn the direction in which their own true interests lay. In the twenty years between 1838 and 1858, the steam factory system developed itself with continually increasing rapidity and energy, and the application of steam power to ribbon weaving, first pronounced impossible and then unprofitable by practical men, was found to be an inevitable practical necessity. A temporary relapse followed, in 1858, but the last two years have shown distinctly that the progress was only checked to recommence with redoubled vigour, and the silk trade of Coventry at the present time is at once more healthy and more extensive than at any previous period. Up to 1858, from the time that steam power had been introduced into the factories, every new factory had been filled with a better class of looms both in size and construction. The power-loom of 1858 was not only more than double the size of that of 1848, but the weaver could also make double the length of ribbon per shuttle. The out-door weavers followed the example of the large manufacturers. Before the crisis of 1858, the old hand-looms had been almost entirely abandoned for the best class of power looms, and cottage factories had been erected by the score, one steam engine supplying the motive power to an extensive group. In 1842, the old Weavers' Association had been reorganised, and the factory operatives had formed another in 1850. But the change from the old system to the new could not be brought about without producing results which told heavily for a time on the interests both of masters and of men. As one manufacturer after another adopted the factory system and erected larger works and more effective machinery than his predecessors, he was able to pay higher wages to experienced hands than the profits of older and smaller looms could afford. The hands at the old factories demanded an equal advance, and if their demand was not complied with, struck work; the circumstances under which these strikes were made rendering them generally successful. Advance after advance was made by the proprietors of the old factories until it became impossible to compete any longer with the "new men," and a return to piecework at list-prices was proposed. To this proposal the factory weavers agreed, and both systems were for some time worked simultaneously, the old factories paying by the piece, and the new by weekly wages.

In 1858, it became clear that, unless a re-arrangement of the new factory prices could be made, the list must be reduced. A dispute between the piece-work manufacturers and their men was followed by a proposal from the out-door weavers for a general return to the piece-work system throughout the district. This proposal was resisted by the manufacturers who paid weekly wages, and the men were threatened with a lock-out, if any attempt were made to enforce it. A notice of strike was given at one factory and a general lock-out followed. Nominally, the weavers won the day. A conference was held, and a list was drawn up; but it was soon found that the out-door weavers, who employed hands to work their looms, refused to observe the conditions imposed on the large factory occupiers, and supplied certain classes of goods at prices with which the manufacturers bound by the list prices could not pretend to compete. Trade in general was slack, and the removal of all restrictions on foreign competition, effected by the operation of the commercial treaty with France supervening on an inevitable crisis, materially aggravated the temporary distress.

The greater part of the factories came to a stand-still. The manufacturers who were not occupiers of factories, announced their intention of disregarding the list, and a general strike of all the weavers in the district followed. After eight weeks, the strike ended in the total defeat of the weavers, the abandonment of all trade regulations whatever, and the utter prostration of the old system. From that day to this no list has been recognised. The labour market is free, and the renewed prosperity of the manufacture is more firmly established than could possibly be the case under any system of protection, either by Government or trade associations.

A "list," in fact, which the weavers used to consider the universal panacea for artisan distress, has now become a practical impossibility. The fluctuations to which the ribbon trade is continually liable, the constant change in the character of the article manufactured, the innumerable gradations in style, texture, and quality, demanded by different manufacturers, to meet the ever varying caprices of particular classes of consumers; the division of the weavers themselves into two distinct classes, a town class and a country class, differing materially in requirements and habits, and consequently governed by a different standard of wages,—the variety of systems on which the trade is conducted, the large steampower factory system, the cottage factory system, side by side with the out-door a-la-bar, hand, and single-hand weavers,—the admission of male and female operatives alike into the trade; the continual improvements introduced in the machinery, all forbid the possibility of ascertaining and establishing any fixed and definite scale of prices. The weavers, generally, still hanker after a "list," but the experience they have gained since 1860, has at least demonstrated that their prosperity by no means depends on their obtaining one, and it is to be hoped, that we have at last seen the end of the disastrous attempts so often renewed to establish a system for the regulation of wages, which can hardly ever be otherwise than either superfluous or unjust.

Many of the foregoing facts in reference to the strikes in the ribbon trade are taken from a remarkably able local pamphlet, published in 1861, by Mr. George Hall, a working weaver, who has since emigrated to Brisbane. It was written with a view to the establishment of a Court of Conciliation and Arbitration between masters and men, an idea highly popular at the time, and still a favourite with theorists of a certain school. The judicious interference of such a body might very possibly on some occasions produce a beneficial effect, but when called upon to adjudicate in case of a strike, it would nearly always labour under the disadvantage of having to deal with certain elements entirely beyond its control. We have learnt by experience that commerce thrives best on a minimum of legislation, and it is hard to understand how a transfer of the powers of legislation to a less competent authority can render their exercise desirable. If there is one thing clearer than another in the history of commerce, it is that neither masters nor men have generally known their own true interests, and that what they expected to be their ruin has almost always turned to their ultimate advantage. Any tribunal, therefore, composed of masters and men in any particular trade, may fairly be expected to take a less correct view of their own interests than the general Legislature of the country; and its decisions, could they be enforced, would in many, probably most cases, prove even more disastrous than direct protective legislation. When to this circumstance is added the difficulty of enforcing such decisions, owing to the obstinate persistency of the laws of nature, the policy of establishing tribunals of the kind may well be doubted. The "struggle for existence," of which strikes are the outward exponent, has always steadily refused to abate at the bidding of Acts of Parliament, and there seems little reason to hope that it would be more amenable to Courts of Arbitration.

Among the many vicissitudes which the ribbon trade has undergone during the last few years, few are more remarkable than those consequent on the discovery of the aniline dyes. Owing to the great beauty and variety of the colours produced by these dyes, perfectly plain ribbons have almost completely superseded the old elaborately figured fabrics in popular estimation. The permanence of the dye and the perfection now attained in the manufacture of the ribbon have also tended to influence fashion in the same direction, the figures on the old ribbons to some extent concealing from observation the fugitive nature of some of the dyes employed, even after they had changed hue, as well as minor imperfections in the weaving. Now that silk can be dyed in colours surpassing the old tints not only in brilliance but in permanence, and a perfectly plain ribbon can be woven in which the most practised eye can detect no imperfection, there exists no longer any practical hindrance to the production of unfigured fabrics for which modern taste has created an abundant demand. The dyeing business has, as may be supposed, undergone a complete metamorphosis. The colours now produced at Coventry are fully equal to those of any of their rivals, British or foreign, and the already almost innumerable new pinks and purples, blues and greens, reds and yellows, are almost daily increased by the addition of some novel variety of shade or tint. The only dye in which Coventry was formerly surpassed by Manchester was black. The new dye works of Mr. Rotheram, however, have supplied the defect, and the manufacturer need no longer go beyond the limits of the city to discover dyes and dyers fully equal to any in Europe. The old fixed belief in the superiority of certain foreign dyes is, however, not yet altogether exploded. A small proportion of silk still finds its way from Coventry to Milan, Lyons, and St. Etienne to be dyed, but the quantity diminishes every year, and in all probability even this small traffic will cease when the Paris Exhibition of 1867 has shown the true relative merits of English and foreign workmanship. One result of the preference for plain ribbons has been immensely to diminish the number of Jacquard looms in Coventry. The Jacquard loom found its way to Coventry very shortly after its first introduction to England in 1820, the first factory at which it was employed being that of Mrs. Dresser. In 1823 there were five Jacquard looms in Coventry; in 1832 there were 600; and in 1838, including those in the neighbouring villages, no less than 2,228. The increase in their number continued, though not at the same rate, down to 1858. Since that time the mortality among them has been immense. In fact, out of about 3,000 looms now employed in the ribbon trade in the city, it is calculated that the number of Jacquards does not greatly exceed 100, probably not less than 2,000 having been destroyed or disposed of since 1858. It must not be supposed, however, that the machinery now employed is inferior to that previously in use. The old single-hand looms had been almost superseded by the Dutch engine looms before 1812, and these again were superseded to an even greater extent by the a-la-bar looms, which first became general in the factories about 1850, though introduced ten years before in the first steam factory. For some years there were only eight others in the city, and it was not till 1857 that they were adopted by the out-door weavers. They have now almost driven the engine looms from the field, and at the present time the old single-hand looms outnumber the Dutch engines by which they were originally superseded. This apparent anomaly is accounted for by the circumstance that the hand looms, about 150 or 200 of which still survive in the country districts, offer certain facilities for making tartans and other ribbons requiring a great number of different coloured shoots which are not possessed either by the Dutch or the a-la-bar engines.

The a-la-bar engines now in use are of very various degrees of excellence. The best now in use in Coventry were built at Basle, in Switzerland, the castings for them being made at Mulhausen. At Basle an immense establishment has been for several years in existence where looms are manufactured by machinery on the interchangeable principle now adopted in this country in the manufacture of small arms, though not carried out in such complete detail, and with less effective machinery. The Basle looms are mostly Jacquards, with two, three, or four sets of shuttles, and work up to a very high speed, 24 dy and 30 dy looms working at a rate of from 85 to 90, and narrower widths from 100 to 120 shoots per minute without difficulty. On the whole, they are superior to the looms of Lyons, St. Etienne, and St. Chamond, and are only surpassed, if they are surpassed, by the patent looms of Mons. David, erected at Dunières.

Under the present trade arrangements, the raw silk imported by the merchants passes into the hands of the silk brokers for sale to the silkmen, in whose hands it undergoes the first process of manufacture, spinning, or throwing, in order to prepare it for weaving. The manufacturer purchases it of the silkman, has it dyed and woven, and disposes of it to the silk merchants of London and Manchester, who in turn distribute it to the trade, the manufacturers having no direct dealings with any retail houses. In transactions between the manufacturers and the silkmen, monthly accounts and two-month bills have taken the place of the five-month bills, once universal, and the whole business is now probably on a sounder footing than at any previous period.

With regard to the material itself, the Italian organzines still maintain their old superiority, China still sends its unfailing supply of Tsatlee and Taysaam, and Bengal still furnishes a large amount of inferior quality, although a manifest improvement is perceptible on the India silk of former days. The principal innovations of late years are the introduction of Japan silk into the market, and the almost total disappearance of the Turkey silk, Brussa shoot—once highly popular and commanding a price equal to that of Italian shoot—being now comparatively unknown. With regard to the Japan silk, which was only introduced about four years ago when the commercial treaty with that country came into operation, opinions differ widely, one manufacturer condemning it in unmeasured terms, while another considers it superior even to the Italian for fine warps. Some samples of it certainly are of admirable quality, but the trade in it has perhaps hardly been hitherto sufficiently extensive and long established to determine correctly the value of the general average. The price it commands is the best test of its real value to the manufacturer. In the raw state, the best Japan at the present time (March, 1866,) may be taken as worth about 36*s*., the best China about 35*s*., and the best Italian about 45*s*. per lb. The price of all silks has considerably advanced of late years. In the "year of Revolutions," 1848, best Italian silk was only worth 16*s*. 6*d*., in 1808 it was worth 100*s*. per lb., the general average of late years being about 28*s*. per lb.

Under the present system, the factory weavers are almost universally paid by the week, the wages of average hands under the recent advance being from about 13*s.* to about 19*s.* per week. In addition to their regular wages, they are paid premiums on finishing the pieces of work, the amount varying according to the time occupied. The wages of an expert hand will thus generally range from 25*s.* to 28*s.* per week, while those slower and less skilful receive proportionally less. Practically, the system is equivalent to payment by the piece with a fixed minimum. Any time lost by the workman is deducted from his weekly wages; any time gained by executing the work quickly is paid for in the premium. The wages of females in the factories range from about 7*s.* to about 10*s.* per week, and for both male and female operatives the wages of out-door workers maintain about the same general level.

At the time of the collapse of the trade, when public subscriptions were raised and other more questionable methods resorted to for the relief of the "Coventry distress," a scheme of emigration was set on foot which drafted out of the city a large proportion of the best and most provident workmen, and an internal emigration also took place to other localities in England where weaving is carried on. The census of 1861 gives 3,267 males, and 6,965 females as the total number of those employed in the silk and ribbon manufacture in the city of Coventry. This number is now greatly reduced, but it is difficult to obtain any accurate statistics. Last year the number of males was estimated by the Weavers' Committee from careful enquiry at about 2,000, and of females at about 4,000; but there is reason to believe that at the present time these figures are considerably under the mark, especially with regard to females.

The prejudice against the factory system still exists in the minds of the weavers, though by no means in so intense a form as twenty or even ten years ago. One result of this feeling on the first establishment of the system was, that the worst classes of weavers found their way into the factories while the more respectable portion held strictly aloof. A broad distinction was thus shortly created between the factory and out-door weavers, founded, not on prejudice, but on fact. The order and regularity, however, of the factory system has, in the course of years, produced a marked result on the character of the workpeople subjected to it. By degrees the worst classes have been eliminated from the factories, while many of those who formerly stood aloof have been attracted into them. They now, therefore, employ the great bulk of what may be termed the middle classes of weavers, the highest and the lowest being now to be found among the out-door operatives.

The present preference for perfectly plain ribbons has left for a time the skill and talents of the ribbon designer in abeyance, but it would be unjust to close a notice of the Coventry ribbon-manufacture without any reference to the marked improvement visible in the designs of English ribbons in late years. Much of this desirable result is no doubt due to the School of Design, which has for many years been ably presided over by artists of acknowledged talent, and liberally supported by the manufacturers. Just at present the beneficial effect of its establishment is felt more by the watch manufacturers than the ribbon manufacturers; but there are not wanting symptoms to show that before long the services of the ribbon designer will again be called into energetic activity.

When the cry of Coventry distress was still ringing in the nation's ears, it was very generally believed that the disastrous condition of the ribbon trade was due to the commercial treaty then lately concluded with France. The foregoing statement of facts shows how very small a portion of the distress was due to this cause. Foreign competition, indeed, or rather the terror of foreign competition, may have somewhat hastened the crisis, but the crisis itself was inevitable, and would have been equally disastrous had the French treaty never been concluded. On the other hand, while the direct competition of the produce of French looms can hardly be said to be felt by the Coventry manufacturer, the indirect competition produced by abolishing the restrictions on trade has undoubtedly been the mainspring of the renewal of his prosperity on a sounder and more enduring basis.

Of the other trades of Coventry it is unnecessary to speak at length, as none of them are peculiar to the city, and their history in Coventry is practically the same as their history elsewhere. The industry which employs the greatest number of hands next to ribbon weaving is watch making, a branch of trade that seems to have settled in Coventry about a century ago. The following census, carefully compiled by one of the benefit societies in 1861, shows the number of hands employed in each department of the trade at that time, and, although a considerable increase has taken place, is still approximately correct. The Government census of 1861 gives 1,943 males, and 68 females, as the numbers employed in watch making in Coventry, a result very nearly coinciding with that here exhibited.

Census of the Coventry watch trade, 1861 :—

Manufacturers	90
Finishers	794
Motioners	74
Jewellers	72
Engravers	32
Gilders	28
Springers	42
Case Makers	38
Cap ,,	36
Hand ,,	3
Index ,,	6
Pallet ,,	3
Balance ,,	15
Dial ,,	33
Pendant ,,	3
Glass ,,	4
Escapement Makers	17
Movement ,,	11
Engine Turners	18
Joint Finishers	4
Fuzee Cutters	4
Clerks	8
	1,340
Apprentices	667
Females	30
	2,037

A number of interesting particulars relative to the watch trade are to be found in the Parliamentary Return on "Watch Cases and Watches" moved for by Sir Joseph Paxton, and printed in 1864; but the statistics given offer no means of comparing the trade of Coventry with that of other localities.

Nearly all the new manufactures in Coventry are of textile fabrics, and were introduced on the collapse of the ribbon trade in 1858. Among them may be mentioned worsted weaving, elastic weaving, and the manufactures of Bradford mixed goods, cambric frillings, and gimp trimmings, both the latter now employing a considerable number of Jacquard looms. Cambric frilling was first introduced by Mr. Cash, and a modification of his invention has since been successfully employed by Messrs. Browett, who are also the principal manufacturers of the various kinds of trimming. Cotton has long been used in the manufacture of certain descriptions of ribbon, and the manufacture of Bradford goods of mixed cotton and wool appears to be now firmly established in Coventry. Whether the manufacture of purely cotton goods can be successfully prosecuted in the Midlands appears to be still an open question. Attempts in this direction have been made in Coventry, and a cotton factory is now in operation at Nuneaton; but the results hitherto obtained can hardly be said to have established the success of the experiment. Few materials are so dependent as cotton on conditions of climate, and it is said that the damper atmosphere of Lancashire gives that part of the kingdom a decided advantage over other districts in this particular manufacture. The truth of this statement, however, has not yet been conclusively proved, and even if true, it by no means follows that the midland districts may not possess an advantage over Lancashire in another direction more than equivalent to the disadvantage of a drier climate. Be the result of this particular experiment, however, what it may, Coventry has now fairly entered on a new career of commercial prosperity, and promises at no distant day to be the principal centre not only of the ribbon trade, but of many other textile manufactures in which the skill and industry of her weavers can be turned to profitable account.

ON THE MANUFACTURE OF NEEDLES AND FISH HOOKS.

By R. S. BARTLEET and J. M. WOODWARD.

NEEDLES of some kind or other have been in use from some unassignable date in the pre-historic ages downwards to the present time, the invention, in all probability, having preceded even that of woven fabrics. The history of the steel needle, however, which in every civilised country has now long superseded the earlier clumsier implement of wood, bone, bronze, or even of gold, belongs, in Europe at least, to ages far less remote, and the processes of the manufacture now employed have almost all been introduced within the memory of the present generation. The Moors would appear to have been the first introducers of the steel needle into Europe, although, as in the case of so many other inventions, the Chinese claim to have used it from time immemorial.

The so-called "Indian," who made needles in London in 1545, was probably the same "Spanish negro," or Moor, who, according to Stow, sold steel needles in Cheapside, and in busy parts of London in the reign of Queen Mary. With him, however, so far as this country is concerned, the secret of the manufacture died, although still preserved among the French and Germans, who had also learnt it from the Spaniards. Elias Krause, a German, was the first to revive the manufacture in England, in the time of Elizabeth; and other needlemakers are said to have come over to England from Normandy and other parts of France during the same reign. In 1650, according to a tradition, the needle trade was established at Long Crendon, by Christopher Greening and his family. They had probably journeyed thither from London, where the needlemakers had now become a numerous body, and where, on the 10th of November, six years later, they were incorporated, and received armorial distinctions. In accordance with puritanical ideas of heraldry, the first crest of the Needlemakers' Company was the "Tree of Knowledge of good and evil," with the serpent entwined around it; but, at a later period, they adopted a Moor's head, wreathed, in allusion to the first introduction of the trade. Their shield may be described thus:—On a field *vert*, three needles *argent*, ducally crowned *or*; supporters, *Adam* and *Eve*. Legend: "*They sewed fig leaves together and made themselves aprons.*"

From Long Crendon the needlemakers seem to have travelled north-westerly, sojourning awhile at Alcester, and finally collecting around Studley and Redditch. Why the trade should have moved into these localities is not clear. It is true that at Long Crendon there is no water power, while it is plentiful between Alcester and Redditch. Around Redditch are mills which date from monastic times, and great dams, no longer used, are to be found between this town and Alvechurch. Emery stones, also, so needful to the scourer, are found plentifully in the neighbourhood. But water power can hardly have been the inducement that brought the needle trade into this neighbourhood; for the first mills used in the trade were horse-mills, one of this kind having been established in 1700 at Studley, for the pointing and scouring of needles, two processes for which the aid of mill power was most required. Before this time needles were scoured by being wrapped up in buckram, with emery-dust and olive oil, and rolled backwards and forwards under the feet of the workman as he sat at work at some other process. Another horse-mill was soon after set up at Sambourne, a village near Studley, now locally famous for its mighty oak. But, after a while, part of an old flour mill, on the Arrow, was fitted up for the pointing and scouring of needles, and horse-mills soon became things of the past. As the trade of the district increased, other flour mills were altered in the same way, and at length the intruding pointers and scourers almost expelled the millers from the neighbourhood; yet all who wanted water power could not get it, and these endeavoured to find substitutes. The steam engine was not yet invented; but a Mr. Seward, a man of wealth and influence, sixty years of age, endeavoured to supply the power requisite by means of a singular kind of windmill, having sails inside, intended to be acted upon by the wind blowing through long, narrow, window-like openings all round the building.

Previous to the year 1563, the wire for the making of eedles was imported from Spain and Germany. For a considerable time after this date the needle makers drew their own wire, and of this wire was made a kind of needle now extinct—the square-eyed needle. In the then rude state of the manufacture the square-eye was the most easily made. It was punched through wire cut to the length of the intended needle, and flattened at one end to receive the eye. Such needles would be much dearer than those of the present day; and, if we consider that in remote villages the opportunity of buying needles occurred perhaps but once or twice a year, at some neighbouring fair, we shall not deem the plot of "Gammer Gurton's Needle" quite so trivial as it first appears to the modern reader, or be surprised to find a whole household disordered by the loss of so scarce, as well as useful, an implement. With these square-eyed needles Mary, Queen of Scots, wrought tapestries for the walls of the room in which she was imprisoned; and, indeed, needles of this shape continued, until within very recent times, to be the only form made.

In 1793 a needle with a new form of eye appeared in the market. This was the "drilled eye" introduced by a Studley manufacturer, who engaged an Alcester watchmaker to drill the eyes of his needles. But this new process was too expensive, and, after losing a considerable sum of money, the old method was again adopted. Three years before, a retired button maker had commenced making sail and packing needles at Alcester, by means of dies fixed in a stamp, after the manner of button making, and stamps also began to be used, about this time, in making bodkins at Studley. But the needle maker had no idea of using the stamp for the smaller kinds of needles until the year 1800, when the use of a stamp or press was suggested by a Birmingham factor who happened to be on business in the needle district. The idea was acted upon, and a press was made, which was intended to form the eyes of 100 needles at a time; it failed, however, to press more than 35 at once, and was finally abandoned in consequence of the disappearance of the man who worked this somewhat complicated machine. A new arrangement of stamp and press for shaping and piercing the eyes one by one, soon after became general throughout the needle district; and this was subsequently improved so far as to enable the workman to shape and pierce the eyes of two needles at a blow.

In 1826, drilled-eyed needles were successfully brought out, the drilling, however, in this case was not intended to make the eye, but merely to clear it after it had been pierced in the press. Still, the drilling often left a sharpness in the eye which cut the thread, until this was at last effectually removed by the burnishing machine, which was first brought into use about 1838. In burnishing the eyes, the needles are now threaded on steel wires of suitable size which have been made rough with a file and hardened. The ends of these wires are then fixed in a machine turned by steam power, and so arranged as to cause the needles to revolve rapidly with an oscillating motion round the wires. In some cases the wires also are made to revolve.

About this time, too, an important improvement was made in the mode of dressing the buffs used in polishing needles.

In 1840, a Redditch manufacturer, unfortunately for himself, revived the practice of hardening needles in oil instead of in water. The effect of this was that instead of the needles becoming generally crooked, as was the case when hardened in water, the crooked needle was the exception; and those who earned their living by the straightening of the "crooks" viewed with alarm the process, which they imagined would take away their means of support. The unfortunate reviver of this process was in consequence repeatedly mobbed, and at length driven from the town. This mode of hardening is, however, now generally adopted, excepting for the best qualities. An equally fruitless opposition had been made, many years before, to the introduction of stamps and presses, and the use of the Sheffield Grinders' fan in the pointing mills was violently opposed until the year 1846, by those for whose benefit it was intended.

There is one more new process to be mentioned—the pointing of needles by machinery. The needle-pointing machine is an English invention, though it is not generally supposed to be so; and its forerunner, which though not perfect, approached so nearly to perfection as to alarm the pointers, was some years ago purchased by them, and broken to pieces on Redditch Church Green. The needle-pointing machine is as yet only partially used in this district. A grooved grindstone revolving at great speed is employed to grind the end of each wire into the desired shape. To this grindstone the wires are applied from an inclined plane, on which a number are placed ready cut to the length required. By means of a disc surrounded with caoutchouc revolving slowly in a direction transverse to the grindstone, a continuous supply of wires rapidly following one after another is supplied to the stone, and the same disc causes the wires to revolve whilst being pointed.

The effects of these improved modes of manufacture are, that needles are now produced in much greater quantities, of much better quality, and at lower prices.

The increase of trade since 1849 has been in about the same ratio as the increase of population. The French treaty has increased the demand for certain classes of goods, while the war in America has caused a great diminution of trade to the United States.

Since its first introduction into England the trade has produced needles of almost endless variety. The ordinary sewing needle was then, and is now the staple article of the trade. Whatever varieties were made in early times appear to have been manufactured exclusively at one or two places. In Oliver Cromwell's time the manufacture of sail and packing needles was confined to Long Crendon, but, after a while, the Alcester needle makers succeeded in transferring that branch of the trade to their town; then, in course of time, came a succession of needles into the market, adapted to the peculiar nature of whatsoever had to be sewed, from the delicately pointed needle of the surgeon to the pointless needle of the harness maker. The tailor, the bookbinder, the straw and felt worker, the sail maker, the saddler, the glover, the embroiderer, the industrious housewife, and the lady with a taste for fancy-work, all required and were supplied with needles suited to their particular requirements, not to mention the many kinds of needles demanded for the legions of sewing-machines which are now bidding for the patronage of the public. Besides all these, are certain implements which should scarcely be called needles —such as the crochet and netting needle, the knitting pin, bodkin, &c. Suffice it to say, that all kinds of needles, in infinite varieties of shapes, sizes, and lengths, suited to the peculiar wants or fancies of the home and foreign markets, are now to be obtained, of matchless quality, from Redditch, the present centre of the trade. Redditch, in fact, has far outstripped all its competitors in the production of every class of needles, which, except in its neighbourhood, are not made to any extent worth notice elsewhere in the United Kingdom. Common qualities are manufactured at Lyons, and one or two towns in Normandy; but the chief seat of the foreign needle manufacture is at Aix-la-Chapelle, in Prussia. The Chinese are chiefly supplied with needles by makers in their own country, where the art is perhaps more ancient than in Europe, and where round-eyed needles were commonly used long before even the square-eyed needle was known here.

Women and girls are employed in all the manufactories, with the usual results; but the regulations regarding married women, in one extensive manufactory at Redditch, deserve especial notice.

In this establishment married women are only allowed to work from 8·30 to 12·30 in the morning, and from 2 to 4·30 in the afternoon; and this arrangement appears to remove the most objectionable effects of the employment of married women in factories, giving them time to make their homes in some degree comfortable, to prepare meals for their families, and to bestow some care upon their children both before and after school, instead of their being allowed to run about the streets until their mothers' return from work, perhaps late in the evening.

The approximate number of persons employed in needle making in the town and district is about 8,000, in nearly equal proportions of men, women, and children; while their earnings would average:—

Children,	from	1/6	to	5/-	per	week.
Women,	,,	8/-	,,	15/-	,,	,,
Men,	,,	12/-	,,	40/-	,,	,,

In social condition the work people are generally above the average in cleanliness and tidiness; acting upon the advice of Polonius as regards their clothing,

"Costly thy habit as thy purse can buy;"

while their homes may bear comparison with those of any town where female labour is monopolised to the same extent in factories. The intellectual status of the town and district is high, the National Schools claiming large grants from Government, and taking a good position in competitive examinations.

Owing to the numbers of allotment gardens, and the arrangements made to provide rational amusements in the shape of Saturday Evening Penny Entertainments during the winter, the Recreation Grounds in the summer, and the efforts made by the Temperance Society at all times, there is not so much drunkenness as generally prevails among a manufacturing population. On the part of the chief employers there has been really a general desire to improve their manufactories, to have them sufficiently warmed in winter, and ventilated in summer, and to provide their work people with comfortable and healthy places to work in.

No better example of the results of sub-division of labour can be found than that presented by the needle manufacturer. Though so small an article, the needle has to pass through 70 pairs of hands before it is considered to be finished and ready for use; and were it not for this sub-division of labour, needles would certainly be much dearer and worse made, since no workman could hope to be as quick or as skilful at all the processes as he whose whole life has been spent in acquiring excellence in his own especial branch.

THE FISH HOOK AND FISHING TACKLE MANUFACTURE.

The fish hook is of almost equal antiquity with the needle. The needle trade was doubtless the first established in the Redditch district; and the manufacture of one delicate article from steel-wire seems to have naturally led to that of another—the fish hook. The materials were at hand; and a little ingenuity, assisted by the knowledge of hardening and tempering, would easily enable anyone to make a fish hook. Everyone in his boyhood has made a fish hook out of a pin; and the maturer brain of a man accustomed to working, hardening, and tempering steel, would easily fashion a fish hook out of the materials used in the needle trade. A family is said to have come to Redditch from Limerick, a city formerly so celebrated for its hooks that a saying is still current, in Ireland, that "every Limerick hook is worth a salmon," and although they came to Redditch as needle makers, it is not improbable that we owe to them the introduction of the fish hook trade into the district. But, however it may have been introduced, the fish hook and fishing tackle trade is now of considerable importance here, and vast quantities of hooks, tackle, and artificial baits are sent to all parts, not only of the United Kingdom, but of the world. There is, too, a kindred trade carried on by a distinct class of workmen, who make eel-spears, grains, and harpoons.

Hooks of all kinds are made here, from the smallest to the largest, for catching both salt water and fresh water fish, as well as some kinds of birds. They are made of all sizes, and of an infinite variety of shapes, whose advantages, in some cases, exist only in the mind of the fisherman, although it is not to be doubted that certain fish require, on account of their strength, or some other cause, special hooks. Still, anglers are so fanciful that many have their pet shapes, without which they would think it useless to go fishing. Artificial flies, frogs, minnows, &c., and baits of every kind, are also made at Redditch. The flies are chiefly made by women and girls; and for this manufacture, which is almost an art, the feathers of certain birds are in great request. Some baits, such as spoon baits, &c., which seem to allure fish merely by their brilliancy in the water, are made of metal, electro-plated, and are the work of men and boys.

These branches of Redditch industry are well known among the mountain streams of Wales, the loughs, locks, and lakes of the United Kingdom, the larger lakes of Switzerland and Italy, and the Norwegian fiords, as the Redditch sea hooks are known to the fishers of Newfoundland, the Dogger Bank, or the South Seas, and the harpoons to the hundreds of vessels which annually seek the Arctic Ocean in quest of the whale or the seal; in short, wherever the finny tribes are found, there will some of these products of Redditch manufacture be found also.

About 600 persons are engaged in the manufacture of fish hooks in Redditch, their ways and social condition, &c., being very nearly the same as those of the needle makers already described.

THE TRADES

OF

BIRMINGHAM:

THEIR ORIGIN, HISTORY, AND PRESENT STATE.

THE INDUSTRIAL HISTORY OF BIRMINGHAM.

By SAMUEL TIMMINS, F.R.S.L.

However difficult the ordinary work of the historian may be, his task becomes almost hopeless when he attempts to trace the industrial history of a town. Where chronicles, state-papers, wills, letters, and other documents exist, the careful enquirer may patiently extract the facts, and may finally arrange them according to their proper sequence and importance. When, however, the industrial history of even a modern town has to be written, the early facts are few or doubtful, the time and order of events uncertain, and the real causes of the origin and localisation of trades are consequently very difficult to find. Only within a very few years have industrial biography and industrial history taken their proper place in the literature of our time. The orthodox historian and biographer have limited their researches to the kings and princes and military heroes of the world; and the men whose genius has given so vast an impetus to the material progress of modern England have too long been neglected and despised. Only in such cases as the history of the steam engine, the rise and progress of our cotton manufactures, the improvements in inland navigation, and the development of the railway system, have the incidents in the lives of eminent men led necessarily to more or less fully detailed accounts of some of the great material resources and products of modern times. Following the excellent example set in the "Pursuit of Knowledge under Difficulties," Mr. Smiles has enriched our literature with "annals of victories" not "less renowned" than those of war, and his "Lives of the Engineers" have given the personal history of some of our noblest national works. In all such enquiries the hero offers a sort of central point of attraction, and important facts may be gathered from his life and letters and those of his immediate friends. In attempting to give some account of the innumerable and varied trades of a town like Birmingham, the difficulties are almost insuperable, and the work can only be accomplished by recording what has been done, and leaving the blanks to be filled up hereafter. In the volume which describes the "Industrial Resources of the Tyne, the Wear, and the Tees," the earliest and a very highly successful work has been accomplished for industrial literature. As, however, only comparatively few trades are included in that locality, and those are in few hands, the task has been much more easy than the compilation of this present work. The productions of Birmingham are so numerous and so varied that no one could be found who could undertake to describe all, and it has, therefore, been found necessary to make the subdivision of labour in this volume almost as extensive and minute as in the various trades of the town. It is proposed, then, in this paper briefly to review the industrial history of the town, and to leave its more important trades to be fully and adequately described in the more elaborate reports.

Tradition has long since assigned to Birmingham a pre-eminence among the metal-working towns, but it is difficult, if not impossible, to ascertain how long the metropolis of the "hardware district" has deserved this fame. William Hutton, the historian of our town, points with a pardonable pride to the scoriæ remains at Aston as evidence of our pre-historic skill in the production and working of iron. On such matters early history is silent, and there is but the vague tradition to guide us in the gloom of the past. Although the great Icknield Street Road passed through Birmingham, there is no trace of any station here—the fabulous Bremenium of Stukeley having been abolished long ago—but in excavations in the middle of the present town Roman remains have been found. The historian Dugdale assumes the reputation of Birmingham as historic in his famous but rather dubious phrase—

> "This being a place very eminent for most commodities made of Iron, was in Edward the Confessor's days the freehold of one Uluuine," &c.—(*Warwickshire*, 1656.)

which apparently does not mean, as has often been supposed, that Birmingham was "very eminent in Edward's days for most commodities made of iron," but only that the place has been famous for such wares, and was the freehold of "Uluuine in Edward the Confessor's days." In such darkness we have only tradition to guide us, and although, doubtless, Birmingham may have made even the war-chariots of Boadicea, the first literary light, the first authentic reference to such fame is in the Itinerary of Leland (1538), where he says :—

> "I came through a pretty street as ever I entred into Bermingham towne. This street, as I remember, is called *Dirtey*. In it dwell smiths and cutlers. . . . . . . There be many smithes in the towne that use to make knives and all manner of cutlery tooles, and many lorimers that make bittes, and a great many naylors, so that a great part of the towne is maintained by smithes, who have their iron and sea-cole out of Staffordshire."

This early sketch of the trades of Birmingham has a special value, as the testimony of an eye-witness, for the words omitted refer to other local matters which Leland has faithfully described. The "cutlers" have, however, long since died out from among us, and the "knives" are made almost exclusively at Sheffield; but "cutting tools" such as heavy edge tools, and "matchets," are still largely manufactured here. The "lorimers that make bittes" for bridles are still found among us, but a large part of the trade has been localised at Walsall; while the "naylors" are chiefly congregated round Dudley and Stourbridge.

Although no positive mention of Birmingham as a manufacturing town is known prior to the one just quoted, there is good reason to suppose that it had an early industrial fame. Even the origin of its name is not quite settled; and while its historian, Hutton, adopts the easy etymology of "Bromwicham" (Broom wych ham), the Domesday Book gives the name as "Bermingeha," which has been kept with various mutations down to our own day. If the name is doubtful, the history is still more obscure, and beyond the name, spelled in more than a hundred ways, absolutely nothing is known.

Birmingham, lying as it does a little out of the line of the antient Watling Street, the original North-western line from London to Chester, was comparatively unnoticed by the travellers of old times. The name of the town is given, however, in a map of the time of Edward III., while Coventry, Warwick, and Stratford are only marked and not named. This may be fairly taken to imply that Birmingham was even then a place of some importance; and the recent researches of Mr. Toulmin Smith have shown, that one of the earliest results of Wycliff's teaching appeared in the erection of the Chapel of St. John, in Deritend, under circumstances which show that the inhabitants of Birmingham were far in advance of many neighbouring towns. It may fairly be assumed that even then Birmingham was more than a mere village, and had some claim to be considered an important place, since tolls had been imposed, and only a century later it had so far advanced as to include an organ maker, who tuned the organ at Halesowen in 1498, and received ten shillings for his work. In the next century, the suppression of the Gild of the Holy Cross, the foundation of King Edward's School, and the various Charities founded or bequeathed, imply that Leland's description is correct, and that Birmingham had become an important manufacturing town.

The seventeenth century affords several references to the increasing industrial fame of Birmingham. A topographical work, published at Oxford in 1627, mentions, "Bremincham inhabited with blacksmiths, and forging sundry kinds of iron utensils." Camden described "Bremicham (as) swarming with inhabitants and echoing with the noise of anvils (for here are great numbers of smiths);" and in the troublous days when Prince Rupert attacked the disloyal town the sword works of Mr. Porter had furnished the Parliamentary army with 15,000 blades. Such articles as sword and pike-heads were readily produced where able-bodied men abounded, where the anvil was the common tool, and where various works afforded facilities for grinding and finishing the blades. Later in the same century, in 1690, we find another mention of Birmingham, in Missen's Travels; and some other trades had grown up in the town since "fine works of rock-crystal, swords, heads of canes, snuff-boxes, and other fine works of steel," are described as seen at Milan; but with the further remark, "they can be had better and cheaper at Birmingham." Various other trades had been introduced into the town by the increased intercourse which had been promoted, and the increased skill of the artisans; and before the close of the century the buckle had become an important article in local trade.

Swords and guns were produced in considerable quantities at Birmingham in the middle of the seventeenth century, as we have already seen in the case of swords; but it is difficult to trace when guns were first made in our town. There is some reason to believe that one Hadley—whose name alone remains—produced the first gun made in Birmingham; but at any rate in 1689 the manufacturers of Birmingham were able to undertake a Government contract for small arms. Local tradition has long preserved a dramatic anecdote in which Sir Richard Newdegate and William III. appear, and in answer to the king's expression of regret that no guns were made in England, Sir Richard replied, "the men of Birmingham can do whatever skill and metal can do." The real facts of the case are fully cleared up by the copies—now first published—of the correspondence, given in Mr. Goodman's report, (see page 408,) showing clearly that the local gun trade was not introduced, as the old tradition asserted, but had existed long before. The question was not whether Birmingham should make guns, but whether they could be produced equal to the Government pattern sent down from London, and at a certain price. In the absence, then, of full details we are fully justified in concluding that not only the sword trade but the gun trade also, had been introduced and carried on with much success long before the Revolution of 1698.

Our local historian—William Hutton—in his usual humourous way, remarks that the "Revolution was remarkable for the introduction of William, Liberty, and the Buckle;" but like many more of our facetious historian's observations his statements are not founded on facts. Long before the Revolution buckles were known, and even in the fifteenth century were used as ordinary appendages of dress. Towards the close of the seventeenth century the fashion of wearing buckles revived and lasted for nearly a century more. The buckles for the knees of the breeches and for the shoes, also, were almost universally adopted, the humblest classes only being contented with "clasps."

During the seventeenth and eighteenth centuries the progress of Birmingham manufactures was simply marvellous. Our town seemed to have the power of attracting within its boundaries artisans of every trade and every degree of skill. Although not situated on any of the great highways of the land, it was near enough to be easily accessible. It awarded almost perfect freedom to all who chose to come. Dissenters and Quakers and heretics of all sorts were welcomed and undisturbed, so far as their religious observances were concerned. No trades unions, no trade gilds, no companies existed, and every man was free to come and go, to found or to follow or to leave a trade just as he chose. The system of apprenticeship was only partially known, and Birmingham became emphatically the town of "free trade," where practically no restrictions, commercial or municipal, were known. Coal and iron were easily obtainable from the growing mines and iron works of Staffordshire, and every facility was afforded by such proximities, and by the numerous water mills and the central position of the town, for the rapid extension of the hardware trades.

The eighteenth century is, however, the great epoch of Birmingham advances, and the chief points in the trade history of this last century must be briefly reviewed. Unfortunately, few materials remain for the history of this comparatively modern period, and the few facts have to be found in various odd places, and arranged as accurately as imperfect chronologies will allow. The only local efforts made to record the details of this remarkable industrial history, until the present volume was projected, were those of Mr. William Hawkes Smith, in his "Birmingham and South Staffordshire," in 1836, and of Mr. James Jaffray, whose "Hints for a History of Birmingham" were published in the *Birmingham Journal* in 1856-57. To each of these authors the narrative of Birmingham industry will always be deeply indebted for the extent of their researches, personal and literary, into the history of the town.

Steel has never been largely manufactured in Birmingham, although one of its streets bears the name Steelhouse Lane—a name derived from Kettle's Steel Houses, which were established at the end of the seventeenth century, and continued in operation opposite the end of Newton-street, in what was then only a "lane," till about 1797. The rise of Sheffield and the excellence of its steel caused a serious competition from the proximity also of the port of Hull, from which the supplies of Swedish iron were received. Steel is made to a large extent in Staffordshire; but until a year or two ago, when Messrs. Thomas Cox and Son revived the manufacture originally for their own convenience in making umbrella frames, the making of steel had not been carried on in Birmingham itself for more than seventy years.

Early in the last century Birmingham was the scene of some experiments, the details of which are not generally known, but which are intimately connected with the rise and progress of that enormous industry, the cotton manufactures of our land. Long before Richard Arkwright had commenced the career which ended in a colossal fortune, the process of "spinning by rollers" was first tried in our own town. In 1700, in a small building near Sutton Coldfield, about six miles from Birmingham, the first thread of cotton was spun by the means which Arkwright subsequently perfected, and from the use of which our vast cotton trade has sprung. This "first thread of cotton spun without the aid of human fingers," was produced by an arrangement of rollers in a model, about two feet square, without a single witness to the work, the inventor (to use his own words) being "all the time in a pleasing but trembling suspense." In 1741 the invention had made further progress, and some yarn "was spun by an engine turned by two asses, walking round an axis in a large warehouse, near The Well, in the Upper Priory, at Birmingham;"—some of the thread being still extant and endorsed with the details by John Wyatt himself. Curiously enough, the Mechanical Section of the British Association at the meeting, in 1865, assembled in the Friends' School Room, which stands on the exact site where this early experiment was tried. Wyatt, like the majority of inventors, was an unsuccessful man, and associated himself with Lewis Paul, who has sometimes been supposed to be the inventor of "spinning by rollers;" but at any rate, the earliest experiments were made at the time and place named.

The process was continued for some time afterwards at the "Cotton Spinning Mill, in the Upper Priory, Birmingham;" and in 1786, an advertisement appeared asking for information from any of the "people now living who were either employed in this work or can describe any part of the machinery then in use." The process of cotton spinning was carried on in Birmingham for some years afterwards; but John Wyatt, Lewis Paul, and Thomas Warren, the well-known Birmingham bookseller, who had paid one thousand pounds for the speculation, were all alike unfortunate, and Warren became a bankrupt in February, 1740. Again, in 1745, misfortune followed Lewis Paul, and his "machine or engine for spinning cotton," and containing "fifty rollers," was again on sale. Another note-worthy fact of local history is that Dr. Samuel Johnson, who was a correspondent of Lewis Paul, was the guest of Mr. Lloyd, (as recorded in Boswell,) in the house adjoining the building where the first experiment, in the Upper Priory, was tried.

The cotton manufacture, or rather the spinning of cotton by rollers, was carried on in Birmingham till nearly the close of the last century. In 1788, Thomas Warren, who had ceased to speculate in cotton-spinning and had become an auctioneer, sold off the machinery of the Cotton Mill, in Birmingham, then "worked by Steam, but equally applicable to Water, without any expense in the Conversion." The details given show that cotton had been spun to a considerable extent, but the experiments seem to have been unsuccessful, and another sale of the "Cotton Mill, in Birmingham" occurred in 1792. Some other attempts seem to have been made, but "cotton-spinning" never flourished in Birmingham, although the first trials of the process of "spinning by rollers"—the key-stone of the great cotton-trade of England—were made in our town long before Arkwright had studied and perfected the machinery on which his fortune was based.

Cotton-spinning was not the only product of the fertile brain of John Wyatt, but he invented also a machine for weighing carriages, carts, and waggons, which is nearly identical with those now used. Even this invention, however, was not employed till after his death, the first being erected in Birmingham, in 1767. Wyatt died in 1766, full of honours, but broken by misfortune. He was followed to the grave by two famous men: by Matthew Bolton, who, when a boy had seen the spinning machine, and who blamed Wyatt's sons for not asserting their father's claims; and by John Baskerville, who, with his usual eccentric habits, arrayed himself, on the occasion, in a rich suit, decorated with gold lace. The original model by which the first cotton thread was spun, remained as late as the end of the last century, and was offered to Arkwright as an interesting relic, but the successful adapter declined to take it, and its ultimate fate is not clearly known.

In 1745, the alarm excited by the Jacobite rebellion gave a great stimulus to the Birmingham trade in swords and guns. Swords especially were in great demand. The sword makers, less scrupulous than when during the Civil War they refused to supply the Royal troops, executed large orders for the army of Prince Charles. In 1744 a large chest of basket-hilted swords, sent from Birmingham to the Belle Sauvage, on Ludgate Hill, London, was seized and taken to the Tower. In October, of the same year, twenty chests containing two thousand cutlasses, sent to the Saracen's Head, were also seized and sent to the Tower.

The button trade, however, formed one of the most important trades in the rapidly increasing town, and the buckle trade was carried on with unexampled success in consequence of the fashions of the day. Buckles were first made in Bilston, at which place they were made down to 1778, when Birmingham had taken the lead. The buckles were generally made, at the end of the century, from a metal called Tutania, which was said to take its name from one Tutin, the inventor; but pinch-beck was used for the commoner sorts, and large quantites "Silver-plated" were produced. Buckles were made in various forms and sizes, from the small buckle on the band of the hat or the knee to the huge shoe-buckle which nearly covered the foot. The prices ranged from one shilling to five, and even ten guineas a pair; and, as the buckle fashion was almost universal, Birmingham and two or three adjacent towns supplied the whole demand for America, Holland, France, Germany, Italy and Spain. In 1790, however, the fashion changed, and the trade rapidly declined. The "effeminate shoe-string," as it was contemptuously called, had replaced the shoe-buckle. A petition of the buckle-makers appealed to the Prince of Wales, in December, 1791, to assist in giving employment to "more than 20,000 persons who in consequence of the prevalence of shoe-strings and slippers" were in terrible distress, and His Royal Highness, and also the Duke of York, ordered their gentlemen and servants to discard shoe-strings at once. "Fashion," to use the words of the petitioners, was "void of feeling and deaf to argument," and so again, in 1792, another petition was prepared and presented to the Duke and Duchess of York. This document claimed that as metal buttons were protected buckles should enjoy a similar privilege. All appeals were in vain. Buckles had had their day, and a great staple trade of Birmingham died out before the century closed.

The button trade, which grew as the buckle trade declined, advanced rapidly during the last half of the last century—metal buttons being chiefly made, and cloth buttons proscribed by law. About 1790 it was discovered that by a "dipping" process a gilt button might be readily and cheaply produced, and so, on several occasions between 1790 and 1795, meetings of the master manufacturers were held to insist on the necessity of marking all buttons, "gilt" or "plated," only when they were really covered with gold or silver, and not merely "dipped." The statutes of 8 Anne and 7 George I. were still in force, imposing a penalty of £5 "on any Taylor or other person convicted of making, covering, selling, or using, or setting on to a garment any Buttons covered with cloth or any stuff of which garments are made," and notice was given that such penalties would be enforced. At one of these meetings Matthew Boulton took the chair, denounced the deception of "marking 'gilt' on buttons which were not gilt, and 'plated' on such as were not plated," and added in characteristic style, "As I am an old button maker, allow me to advise my brethren to make excellence rather than cheapness their principle of rivalry; and pardon me if I advise the merchant to be satisfied with buying good commodities at a fair price, to lay aside the arts of reduction, and not to expect to buy his goods cheaper than any other man who has money in his hands." The metal button trade was doomed to decay, and fashion had her way. As late as 1830, and even 1850, other deputations were sent asking for royal and courtly patronage for metal buttons, but all in vain. Fashion rules with absolute unbounded power, and no amount of appeal or argument can check the excesses of crinoline or bring metal buttons again into use.

During the last century, Birmingham earned the famous name given by Edmund Burke, "the toy-shop of Europe." This phrase has been generally misunderstood, for the word "toy" has now acquired a different meaning, and had a special technical reference in the days of Edmund Burke. The "toys" of Birmingham have always been the trinkets, as they would now be called, made in endless varieties, and formed from steel. They were not the "toys" of children, nor the toys of men, but that large class of wares made from steel or well-hardened and well-polished iron. The toy trade of Birmingham, a century ago, included even the buckles, the purse mounts, the châtelaines, the brooches, the bracelets, and the endless varieties of steel watch-chains, sword hilts, and other small wares in iron, or iron and steel. In our day, the phrase still remains, but in a divided form. The "light-steel toy trade" includes most of the articles just named, with the addition of key rings, key swivels, &c., &c., while the "heavy steel toy trade" is a misnomer, few of the goods being "heavy," very few all "steel, and none at all "toys," in the modern sense of that word. A century ago, before gold was common, or silver comparatively cheap, steel goods for male and female wear were highly fashionable; and the "toy trade" of that age represented and anticipated the extent of the jewellery trades of the present time. Oddly enough, the revival has commenced, and Birmingham manufacturers are working up old buckles, studs, and other light steel ornaments which the revolution of the wheel of fickle fashion is bringing into favour again.

Buckles, buttons, toys, and papier mâché, were not the sole productions of Birmingham during the last century. Whatever class of art existed in the community at large found some reflection, and exerted some influence in our town. While the men of Birmingham were making swords, guns, buckles, and buttons, and supplying the common and material wants of mankind, the love of art, and the aspiration for something higher, found full expression, and produced unparalleled results. Early in the century, John Baskerville had come to Birmingham, had started in life as a cutter of "grave-stones in any of the hands" at his house in Moor-street—his window slate being still in existence, and showing, in a marvellous manner, the form and style of the "letter" he afterwards delighted to produce. As a "writing-master" and a "grave-stone cutter," he passed his early days, became a japanner, and made a fortune by his trade. He then embarked with his indomitable energy in the manufacture of a series of type, which should surpass all previously known. Six hundred pounds were spent before he had made a single letter to please his fastidious taste. In 1758, he published his magnificent edition of Virgil—for which Matthew Boulton was one of the first subscribers—and this was followed by a series of classics, which have deservedly enjoyed, not merely a European, but a world-wide fame. Wherever the art of printing is admired, and its choicest works are collected, there the Birmingham printed works of John Baskerville find a high and honourable place. Not only did he design and cast his unrivalled type, but he made his own paper, prepared his own ink, worked his own presses, and probably bound some of his own books. Great as the triumphs of the art of printing have been, and numerous as are the laurels which Birmingham has won, there are few nobler chapters in our local story than those which record how, a century ago, in a material and commercial age, John Baskerville made our town famous throughout the civilised world for the production of the best and greatest works of man, in a style which has rarely been equalled, and even now, has never been surpassed.

The story of Soho has been so well told in the lives of "Boulton and Watt, Engineers, Birmingham," by Mr. Smiles, that the full narrative need not be given here. The history of Soho is not only one of the brightest chapters in the annals of our town, but is one of the greatest incidents in the industrial history of our land. While James Watt was musing over Newcomen's engine, and devising those improvements which made him the real inventor of that steam-engine, "which enlarged the resources of his country and increased the power of man," Matthew Boulton was pushing his way as a manufacturer of "toys" at his works in Snow Hill, little dreaming that on the barren heath at Handsworth he was hereafter to immortalise his name. Among the industrial heroes of the world and the greatest men of Birmingham, Matthew Boulton will ever hold the loftiest place. Long before Soho was founded he set himself to show that the vulgar prejudice against "Brummagem wares" was wholly undeserved. His buckles, his clasps, his chains, all that he produced, were designed in the best fashion of the day, and worked out by the best men he could procure. It was well said of him that he "would buy any man's brains," and this was the secret of his success. He took men as he found them. He did not expect perfection. He patiently trained them to their work if they were inexperienced before. He was a keen judge of character, a clear-headed catholic-minded man—a very "chieftain of labour," who knew how to put every man in his proper place, and to make the most of all. His pleasant manners, his genial temper, his unflinching justice, made him honoured, loved, and feared. While he was generous, he was just; and in the difficult art of managing men he has never been surpassed. He exacted the best of everything—the best of material—the best of work—the best powers of his men—and he reaped his reward. He was the "father of Soho," and what Soho was the following contemporary account may show :—

> This place is situated in the Parish of Handsworth in the County of Stafford, two Miles distant from Birmingham. The building consists of four Squares, with Shops. Warehouses, &c., for a Thousand Workmen, who, in a great variety of Branches excel in their several Departments; not only in the fabrication of Buttons, Buckles, Boxes, Trinkets, &c., in Gold, Silver, and a variety of Compositions; but in many other Arts. long predominant in France, which lose their Reputation on a Comparison with the product of this Place: And it is by the Natives hereof, or of the parts adjacent, (whose emulation and taste the Proprietors have spared no Care or Expence to excite and improve) that it is brought to its present flourishing State. The number of ingenious mechanical Contrivances they avail themselves of, by the means of Water Mills, much facilitates their Work, and saves a great portion of Time and Labour. The Plated-Work has an appearance of solid Silver, more especially when compared with that of any other Manufactory. Their excellent, ornamental Pieces, in Or-Moulu, have been admired by the Nobility and Gentry, not only of this Kingdom, but of all Europe; and are allowed to surpass anything of the Kind made abroad: And some Articles lately executed in Silver-Plate, shew that Taste and Elegance of Design prevail here in a superior Degree, and are, with Mechanism and Chymistry, happily united. The environs of this Building was Seven Years ago a barren, uncultivated Heath; tho' it now contains many Houses, and wears the appearance of a populous Country: And notwithstanding the number of People in that Parish is double what they were a few Years since, yet the Poor's Rates are diminished, which is a very striking instance of the good effects of Industry. (Swinney's Birmingham Directory, 1774.)*

Great as the genius and invaluable as the inventions of James Watt were, they would have been wasted but for the indomitable energy, the untiring hopefulness, and the commercial genius of Matthew Boulton. Where the timid and invalid inventor would have failed, and have left his great discoveries to be revived when he had long departed, Matthew Boulton gave exactly the element of commercial success. His refined taste, his unbounded energy, his almost reckless profusion, had made Soho famous even for its minor manufactures; but when the steam engine was added, its success was complete. After endless troubles, wearying delays, disasters of all kinds, perseverance had its reward, and Boulton and Watt have a united and immortal name. While Watt was a quiet, patient plodding inventor, retiring in manners, and nervously anxious, Boulton was a man of the world, ready in resource, sanguine in temperament, never disheartened by the most threatening disasters, and never "bating one jot of heart or hope." Full and able as the sketch of him by Mr. Smiles is, there are some points not thoroughly shown, but which may be seen in a thoroughly characteristic speech which he delivered when the Soho Foundry was established in January, 1796. The Foundry had been completed, and the "rearing feast" was held, with M. R. Boulton in the chair. Matthew Boulton arrived afterwards, made a short apology, and then proceeded :—

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* After the death of Baskerville, M. Swinney continued the business of type-founding, and was the only type-founder in the provinces for many years.

> "I come now, as The Father of Soho, to consecrate this place as one of its branches. I also come to give it a name and my benediction. I will, therefore, proceed to purify the walls of it by the sprinkling of wine, and, in the name of Vulcan and all the gods and goddesses of fire and water, I pronounce the name of it Soho Foundry. May that name endure for ever and ever, and let all the people say Amen, Amen! This temple now having a name, I will propose that every man fill his pitcher, and drink 'Success to Soho Foundry.'"

Mr. Boulton then proceeded to give the establishment his benediction :—

> "May this establishment," said he, "be ever prosperous; may no misfortune ever happen to it; may it give birth to many useful arts and inventions; may it prove beneficial to mankind, and yield comfort and happiness to all who may be employed in it. As the smith cannot do without his striker, so neither can the master do without his workmen. Let each perform his part well, and do their duty in that state to which it hath pleased God to call them, and this they will find to be the true rational ground of equality. One serious word more, and then I have done. I cannot let pass this day of festivity without observing that these large piles of building have been erected in a short time, in the most inclement season of the year, without the loss of one life or any material accident. Therefore, let us offer up our grateful thanks to the Divine Protector of all things, without whose permission not a sparrow falleth to the ground. Let us chaunt Hallelujahs in our hearts for these blessings, and with our voices (like loyal subjects) sing God save great George, our King."

Which was done in full chorus, and amidst the discharge of cannon.

Matthew Boulton had however, not merely the commercial power which can make a speculation "pay," but he had a large share of mechanical and engineering skill. The mint-machinery which he devised is used even now with but few alterations. He saw how bad and how imperfect the copper coinage had become, and at last his firm was appointed to produce that excellent coin, which is still known as the "Boulton" copper. Great as his skill and untiring as his industry were, his machinery failed to produce an "inimitable" piece, and his splendid coinage was counterfeited soon after it appeared by lead pennies faced with copper, in 1797. The new pennies so sadly needed, were sold at first at 1½d. and 2d. each. In order to afford a simple means of testing the genuineness, the two-penny pieces weighed 2oz. each, and eight of them measured a foot; the penny pieces 1oz., and 17 measured two feet; the half-penny pieces ½oz., and ten measured a foot; while the farthings ¼oz. each, and twelve measured a foot. Sixteen pennies genuine weighed a pound, while the counterfeit were often 84 to the pound, and twenty tons of copper making 716,800 pennies, were struck every week, for many months. "Excellence" was Boulton's aim in every branch of manufacture, and this excellence he attained in all he undertook.

The varied productions of Soho cannot be described in detail, but one or two matters must have a passing word. Not only steam-engines and pumps, plated wares, buckles, or-molu wares, candelabras, vases, and every variety of ornamental goods, were produced but the genius of James Watt, (assisted by some remarks of Priestley) had perfected the now common "copying machine." When Boulton showed it in London several M.P.'s feared that it would produce forgeries of bank notes, but it slowly worked its way into favour. Another mysterious process was practised at Soho—the production of paintings by some unknown means—a process apparently begun by Francis Eginton, and ultimately suppressed. Watt, Wedgwood, and their friends, were quite familiar with the fact that nitrate of silver might be made to receive impressions, but there is no evidence that such an impression was ever "fixed." The two silver plate pictures recently discovered, were of late date, and were probably the work of Mr. J. Murdock, who was one of the earliest local students of Daguerre's new art. The paper pictures—those Bartolozzi-looking drawings—were sold from Soho in considerable quantities, and were evidently produced by a plate or plates, and some form of press. Two paintings of large size, apparently by Loutherbourg, have been preserved in Birmingham, and mistaken for real oil-paintings, but prove, on full examination, to have been produced by mechanical means. Some process was suppressed at the wish of Sir W. Beechey, apparently in the "interest of art," and Eginton's process seems to have been the one. While the exact means by which the oil-colour pictures were copied is still doubtful, and the method seems to have been curious but costly, there is practically no evidence to induce the belief that any photographic process was employed.

Soho, under Boulton's management, absorbed all the best talent of the land, and even Flaxman, Chantrey, and Wyon were engaged to provide designs for the multifarious manufactures of the Works. The genius of Boulton foresaw the mechanical triumphs of modern days. Experiments in artillery, in clock-making by machinery, in telescopes, &c., were made, and always with success. In spite of Boulton's practical skill, and Watt's inventive genius, the resources were rude, and the machinery imperfect as compared with our own day. Nearly all depended on the individual workman's skill; and the training under Boulton's own eye produced the well-known "Soho workmen," whose services were sought directly or indirectly wherever their fame had spread.

Among the men who made Birmingham deservedly famous during the last century, and who by their researches and examples influenced so largely the industrial progress of the town, the well-known Lunar Society takes an honourable place. Dr. Priestley, Dr. Withering, Dr. Darwin, Boulton, Keir, Small, Galton, Edgeworth, Day, and Murdock, met frequently to discuss the scientific advances of their time, and their meetings were continued for some years, till deaths or removal, had broken up the pleasant circle.

William Murdock is entitled to the honour of first practically showing the illuminating powers of gas on the façade of Soho, at the Peace of Amiens, in 1802, and was for many years one of the ablest engineers, associated almost on equal terms with Boulton and Watt.

It is simply impossible in the limits of this paper to do anything like justice to the Soho Works in all the variety and excellence of their products. Even down to our own day Soho Plate has remained unsurpassed. Eighty years ago very few towns had nobler or abler residents than Birmingham, and their influence was found in every branch of manufacture, and in every walk of art. Matthew Boulton had grouped around him the best men in every department, and hence the unrivalled fame of Soho—now unfortunately only the *nominis umbra,* of whose former glory nearly every vestige is gone so far as material relics are concerned.

The papier mâché trade was another of the additions made by the skill of Birmingham workmen to the great manufactures of the town. Henry Clay, who first employed the process, had been engaged under Baskerville, and some have supposed that the great printer was really the discoverer of papier mâché, but late researches now assign the honour to Henry Clay. In this, as as in other cases, the fuller details will be found in the following reports, and it remains only to review some of the principal developments of Birmingham trade. The increased facilities of communication, the formation of canals, the demand for guns and swords, all combined to promote the progress of the town, and its advances were rapid in its manufactures, population, and wealth. During the latter half of the last century many new trades had been added, and down even to our own day, every year, and almost every month brings forth some new invention or some new trade.

Among the most remarkable additions traceable during the past seventy years are the extensive jewellery trade—which produces not only the cheap gilt toys sold at remarkably low prices, but the highest classes of silversmiths' and goldsmiths' work—the manufacture of steel pens, metallic bedsteads, and electro-plate, and many other minor trades. In the following pages ample details are given of many of the principal products, but a very large number are not even named. The brass trade will be found the chief industry of Birmingham, while guns and jewellery follow closely in its wake. Every variety of metal and of iron is made up in some Birmingham trades, the cutlery of Sheffield being the chief exception. There are among the minor but interesting trades a large number which can only be named, as brush-making, iron safe and lock-making—a Birmingham lock, that of Mr. Edwin Cotterill, having resisted the skill of the famous Hobbs—scales and weights, percussion caps, galvanising on a great scale, pencil-cases, corkscrews, quoits, tortoiseshell work, walking-sticks, window blinds, &c., &c. In fact, almost every metallic article, whether used in the shop or in the house, whether at home or abroad, is more or less directly connected with some of the Birmingham trades. Not only metal work, but such trades as those of fancy leather, dressing-cases, writing-cases, &c., employ a large number of hands, and the manufacture of photograph-cases has become an important trade.

The peculiar characteristic of industrial Birmingham during the last century was the large number of small masters employing a few workmen in the various trades. The Soho establishment was the principal exception to this rule, and was the first factory of any importance erected in or near the town. The tendency of modern times, especially during the last ten years, has been to the absorption of the smaller workshops in the larger factories carrying on a variety of similar trades. The history of every trade and every manufactory is really that of a rapid growth. Beginning as a small master, often working in his own house, with his wife and children to help him, the Birmingham workman has become a master, his trade has extended, his buildings have increased. He has used his house as a workshop, has annexed another, has built upon the garden or the yard, and consequently a large number of the manufactories are most irregular in style. Whenever the business has overgrown its early home, and it is necessary to remove or to rebuild, a better class of building is invariably adopted. The warehouses, the workshops, and the offices erected during the last few years, all show not only great attention to physical wants and sanitary laws, but generally some appreciation of ornament, and some love of art.

Birmingham is in fact—Sheffield perhaps only excepted—the town of all others where the social and personal freedom is extreme. The large number of small manufacturers are practically independent of the numerous factors and merchants they supply. The workmen, mostly untrammelled by trades' unions, are paid according to their merits, and skilled labour of all sorts is nearly always in demand. The enormous variety of the trades renders general bad trade almost impossible, for if one branch is "slack," another is usually working "full," or even "overtime." In no town in England is comfort more common, or wealth more equally diffused. If millionaires are few, absolute poverty and wretchedness are also rare. Dwellings, however humble, are not overcrowded, as in many large towns; and very rarely is more than one family found in one house.

The habits of the people, generally, have changed greatly for the better during the past thirty years. The "bull-baiting" and "cock-fighting," of sixty years ago, have died out; and the numerous railways which converge in Birmingham, have afforded ready and cheap facilities for the mass of the working-classes to enjoy a holiday, breathe the fresh air of mountains, and the coast of Wales—advantages unknown, even to the mass of the middle-classes sixty years ago.

It was originally intended to include in this paper a mass of statistics relating to the Birmingham trades, but the volume has extended so far beyond the limits originally assigned, and so much has been given in the reports which follow, that it has been found necessary to abandon the course proposed. The materials for such a survey are necessarily imperfect, but they show an advance during the last seventy or eighty years unrivalled in the industrial history of any other town, and an extent and a variety of manufactures beyond all belief, as the products of Birmingham and its neighbouring towns.

BRASS AND BRASS MANUFACTURES.

THE EARLY HISTORY OF THE METAL; THE INTRODUCTION OF THE MANUFACTURE OF BRASS INTO ENGLAND; ITS DEVELOPMENT; INTRODUCTION INTO BIRMINGHAM; PROGRESSIVE AND PRESENT CONDITION OF THE MANUFACTURE.

By W. C. AITKEN.

It is matter of regret that, with the exception of a brief, indefinite, and partial allusion to the Brass trades of Birmingham, made by William Hutton, to be found in his celebrated history of the town, we have no record to guide us as to the introduction, rise, and progress of one of our now most important branches of local industry.

The Brass manufactures of Birmingham, and their introduction into the town, appear to present an exception to the ordinary rule, viz., that some circumstance of ancient date now little known had a share in determining the locality of particular manufactures, and equally so as to the idea that in the early history of a manufacturing community, before cheap modes of transport were extensively introduced, it will be found almost always that manufactories were placed near those spots where nature produced most abundantly the raw material. As regards the manufacture of brass articles, if we except the fuel which is in the immediate vicinity of this town, and an abundance of fine casting sand of which to form the moulds in which the articles are cast, no natural facilities present themselves favourable over any other locality, calculated to make Birmingham the head quarters of brass founding and the brass trade. The reader need scarcely be reminded that copper, which is the principal metal used in the production of brass, as also calamine, or ore of zinc or spelter, the union of which with copper produced and now produces brass, are both metals procurable only at some distance from Birmingham.

There is, however, one element which operated far more potently than the presence of raw material, that is the existence of skilled labour, or industry trained in a particular direction. This, from personal observation, we believe to be hereditary, transmissable and transmitted from sire to son, even down to specialities or special kinds of manipulations of materials. Thus, in a Birmingham working population there is a tendency to perpetuate a special qualification for the manipulation of metals. On this head Mr. Smiles remarks, "There seems reason to believe that the capacity for skilled industry is to a certain extent transmissable, and that the special aptitude for mechanics which characterises the population of certain districts is in a great measure the result of centuries of experience, transmitted from one generation to another." Combe says, "Form, size, and quantity of brain are transmissable, and hence dispositions and talents are transmissable also." Morell maintains equally "That the power of specialised instincts is transmitted, and, when the circumstances favour it, goes on increasing from age to age in intensity, and in a particular adaptation to the purposes demanded. All confirmed habits which become a part of the animal nature, seem to be imparted by hereditary descent; and thus what *seems* to be an original instinct, may, after all, be but the accumulated growth and experience of many generations."

It is impossible however to claim for archaic Birmingham artisans the merit of furnishing the ancient Britons "with the swords, spears, shields, and scythes of *iron* with which they fought and resisted their Roman invaders," as has been done by Hutton when he says, "We have every reason to believe our forefathers were supplied with the necessary implements of war by the black artists of the Birmingham forge"—the historian here appears to have forgotten, in his zeal for his adopted town, that there is no evidence to prove that at the time of the Roman invasion that industry in iron was at all in existence, the manipulation of that metal understood, or its existence known; whereas there is abundance of evidence on the contrary to prove that the weapons used by the ancient Britons were composed of bronze, produced from the copper and tin procured from the mines of Cornwall.

There are, however, authorities to guide us as to the knowledge that as a metal working locality Birmingham has long been celebrated, and we are told that its superiority in the manufacture of cutlery and hardware was as conspicuous in the days of Henry VIII. as it is at present. Confirmation of this we gather from the Itinerary of old Leland, who tells us, in the quaint language of the period, that "There be many smithes in the town that use to make knives and all manner of cutting tooles, and many lorimers (*i.e.*, bridle cutters or saddlers) that make bittes, and a great many naylors; so that a great part of the town is maintained by smithes, who have their sea-cole out of Staffordshire." In reference to the "lorimers" it is curious to remark that their existence as a trade is confirmatory of the existence at the period of the manufacture of leather (one of the earliest manufactures of the town), the use of which in connection with metal is, as is known, very ancient, and is a combination such as promises to endure as long as the human species. The trade of the lorimer still exists as a special business, trade, or manufacture practised in Birmingham and Walsall, and is known as that of saddlers' ironmonger. It is alluded to, as it is more than probable that the earliest or among the earliest introductions or applications of brass were as decorative enrichments to the results of the lorimers' or saddlers' ironmongers' labours. After the lapse of half a century from the period alluded to by Leland, Camden writes of Birmingham as "swarming with inhabitants, and its streets resounding with the noise of anvils." It will be remarked that both the authorities quoted conveyed the impression that, for a long series of years prior to their visits, the inhabitants of Birmingham were familiar with the manipulation of metal, that metal being iron. Brass is not named, nor could it possibly have been; the manufacture of brass, as will be shown, was only introduced as a manufacture into England about the middle of the reign of Queen Elizabeth, though there are reasons for supposing that brass was known in England so far back as the reign of Henry VII., that monarch prohibited the exportation of copper as the doing so might interfere with the production "of brass guns."

The intention, in giving prominence to the working of iron, is to show that the inhabitants of the town had acquired a certain amount of skill in the working of metals, which they could readily adapt to the working of the new metal, brass, when it was presented for their acceptance to be worked on. However much division of labour may operate, as it now does, in circumscribing the individual manipulative skill of the artisan, one thing is certain, that at a former period the worker in metal worked equally well and with equal facility in all metals; there is, therefore, every reason to believe that on the introduction of the new metal, brass, into Birmingham it found an almost ready trained class of artisans prepared to deal with it. The preparation of a mould in which to cast iron is identical with one in which to cast brass; a fitter of articles in iron could and would easily adapt himself to the fitting together the several portions of articles in brass—a metal much more easily turned or filed than iron. The earlier styles of finish in both metals were identical, *i.e.*, they were polished by abrasion or friction, and hence the facility with which the production of articles in Brass or Brass founding naturally, as it were, took its place among the trades of Birmingham. In the brief space of some fifty years after the introduction of the new metal, the manufacture of articles in it had become one of the specialities of the manufactures of the town, and so important had the demand for brass articles of Birmingham manufacture become, that the demand for the raw material procured from Cheadle, Macclesfield, Bristol, and elsewhere, previous to 1740, in that year induced a spirited manufacturer of the name of Turner to embark in the manufacture of brass. The first brass house erected in Birmingham was in Coleshill Street, and occupied the ground immediately in front of that, on which stands the solid brass tube manufactory of Alston and Green, now the property of and worked by The Elliots Metal Company.

Hutton maintains that the only, at all events the chief, manufacture of Birmingham from its earliest existence to the restoration of Charles II., was in iron, "Of this was produced instruments of war, and husbandry, furniture for the kitchen, and tools for the whole system of carpentry." In reference to Brass Foundry he states, that though curious, it is less ancient than profitable, and less healthful than either. He declines to enquire whose grandfather was the first brass founder, and leaves that knotty point to their grandsons, to settle with his successor who should next write the history of Birmingham, and, evidently drawing on his imagination for his facts, *believes* that the first Tubal Cain, so far as regards brass in this town, figured in the reign of King William, *i.e.*, somewhere between the years 1689 and 1702; and though he "sold his productions at an excessive price, he did not, like the moderns, possess the art of acquiring a fortune."

It is curious to remark that whereas in the introduction of the manufacture of brass into this country Birmingham is not entitled to any credit, yet such is the assimilative and adaptive nature of its industry, that in a very few years after the introduction of a knowledge of that metal into the town, it rapidly absorbed, and may now be said to have almost monopolised the manufacture of articles in brass; the spirit of its manufacturers, the skill of its artisans, gave the alloy new forms, and applied it to purposes until then unthought of. What Manchester is in cotton, Bradford in wool, and Sheffield in steel, Birmingham is in brass; its articles of cabinet and general brassfoundry are to be found in every part of the world; its gas fittings in every city and town into which gas has been introduced, from Indus to the Poles—on the railways of every country and on every sea, its locomotive and marine engine solid brass tubes generate the vapour which impels the locomotive over the iron road, and propels the steam-boat over the ocean wave—its yellow metal bolts, nails, and sheathing hold together and protect from decay "wooden walls" of our own and other countries' ships—its "Manillas," once made in tons, are the circulating medium of the natives of the Gold Coast—and its rings and ornaments of brass, sent out in immense quantities, are the chief decorations of the *belles* on the banks of the distant Zambesi.

Having introduced the subject, attention will now be directed to the early history of Brass, the introduction of its manufacture into England, where made, how it was and is now made, and the sources of supply of the copper and zinc, of which it is an alloy.

Though mention of the metal Brass, or a word translated as brass, is frequently introduced by early sacred and profane writers, there is not the most remote probability of identifying it, or the so-called brass, with the metal which bears that name in the present day. The word should not be translated brass, since brass is a combination of copper and zinc, and all specimens of ancient objects formed of "æs," and translated and supposed to mean brass, are found upon analysis to contain no zinc. The brass of an early period of the world's history was unquestionably a mixture of copper and tin, which constitutes or forms the alloy called Bronze. The early references, therefore, in the Bible to the "hills from which brass might be dug," with numerous other allusions to brass must not, therefore, be accepted literally to mean the metal known as such in the present day. As weapons of wood, bone, or stone preceded those formed of metal used by the aborigines of every country, so bronze preceded brass. "The bronze age" was a reality, as the existing antiquities in the museums and private collections abundantly demonstrate. Sir Gardner Wilkinson believes that the granite which forms the materials of which the temples and obelisks of Egypt were built, was cut and incised with chisels of bronze. Layard exhumed from the mounds which mark and cover the site of Nineveh, portions of swords, armour, tripods, cooking utensils, and innumerable objects made of bronze. In Greece bronze equally formed the metal used for useful and ornamental purposes. In Italy, at first, a similar combination of metals was used for the production of objects of utility and ornament. In Russia the produce of its copper mines, mixed with tin (in greater proportion) took, in addition to useful forms, that of immense bells. In France, Germany, and Sweden the early inhabitants of these countries fought with bronze weapons, and the ancient Britons resisted the legions of Imperial Rome with "celts," swords, and daggers also of bronze, the copper and tin of which it was composed being procured from the mines of Cornwall. In all the examples of existing metallic remains, these early works, when subjected to chemical analysis, give distinct traces of tin—zinc is absent; that ores of copper and calamine may have been found in close proximity to each other, and were melted together accidentally by ancient metallurgists, is not to be doubted—the result produced the "yellow copper" of the ancient writers; but it is very evident that the cause which produced the change in colour, was not understood until after the Christian era, and then only by nations considerably advanced in civilisation and refinement. Chief among these were the Romans, who issued coins which, on being subjected to an analysis, give distinct evidence of zinc in alliance with copper in proportion approaching very nearly the brass of the present day. A metal designated by the Romans as Orichalcum or Aurichalcum, appears to have been composed of the same metals as our brass. Watson, in his Chemical Essays, published in 1786, maintains the identity of the two metals—in this opinion he is confirmed by Dr. Percy. The similarity of certain mixtures of copper and zinc, somewhat richer in copper than the ordinary brass, and therefore more golden in hue, will account for the fraud so easily perpetrated by Vitellus on the temples of Rome by despoiling them of their gifts and ornaments of gold, and replacing them by similar objects in Orichalcum. It, however, must be admitted that Pliny appears to have arrived at very nearly a solution of the brass problem; he had observed that copper placed in close proximity to cadmia or calamine, *i.e.*, ore of zinc, on being exposed to heat, increased in weight, by absorption of the calamine; and he evidently thereby anticipated the process of converting copper into brass by cementation, as practised in England after the lapse of 1700 years from the period in which he lived.

Corinthian brass, was not brass at all, but a composite metal accidentally produced by the conflagration which devastated the city of Corinth, and fused together, indiscriminately, its treasures of art, composed of gold, silver, copper, and other metals, the so-called brass varying in colour as the gold, silver, or copper preponderated in the mixture.

The brass of Delos was that which first became famous; all the world came to purchase it (at least, so says Pliny), and Birmingham cabinet brassfounders may be interested in knowing that the Delian artisans were celebrated for the feet and supports of dining couches made of their brass. Æginetan brass was celebrated for the skilful manner in which it was annealed, and probably it would be found that the works made there were produced by the "repoussé" or "beaten" method of working. The island of Ægina was, it appears, famous for the manufacture of sockets only, for lamp stands, while Tarentum was equally so for the branches.

The desire for conquest, which in so peculiar a manner distinguished ancient Rome, was doubtless the means of carrying into the countries subdued by its legions a knowledge of the arts they practised, and to this may be attributed an advance in the metallurgical arts north of the Alps. Germany and Flanders acquired and practised the manufacture of brass at a very much earlier period than England; and we have abundant authorities which show that the thin plates or slabs of "laton," or "latten," or "brass," of which so many are to be found in our cathedrals and churches, and which have been used as monumental brasses—the material on which the inscriptions are incised or cut—were procured from the countries named. In Westminster Abbey, "that temple of silence and reconciliation, where the enmities of twenty generations lie buried," we have the monuments of Henry III. and Queen Eleanor, made in the years 1272 and 1295, by William Torrel, an Englishman; and 165 years thereafter, in 1460, was erected in the Beauchamp Chapel, at Warwick, that most magnificent monument in brass which covers the remains, and commemorates the greatness of Richard Beauchamp, Earl of Warwick, also the work of an Englishman, *i.e.*, William Austin, citizen and founder of London. In all probability, the brass out of which these works were made was imported from Germany, the Netherlands, Flanders, or from the town of Nuremberg—the Bavarian Birmingham of that day—which, among the other specialties for which it was celebrated, numbered brass sheet metal, and brass wire of great excellence, in addition to its other hardware products.

But England had within her bounds all the elements for the manufacture of brass of the best quality: she had abundance of labour to be directed, forests from which to procure wood charcoal for smelting, and mineral fuel; the sea-washed mountains of Cornwall were rich in copper ore; those of Somersetshire and Derbyshire, &c., possessed abundant supplies of the ores of zinc. Intelligence alone was needed to work the raw materials profitably. In the reigns of Henry VIII. and Edward VI., several Acts were passed prohibiting the exportation of brass, &c., under the penalty of forfeiting double the value of the quantity exported. It was not, however, until the reign of Queen Elizabeth that any systematic effort appears to have been made to economise the mineral and metallurgical resources of this country; by doing so, she furnished the means of increasing the supply of material for old industries to operate on, and created new. Chief among the latter was that of the manufacture of brass. Other branches of industry were introduced into this country, by encouraging foreign artisans—such as the manufacture of cloth, silk, and glass. A similarly wise policy marked the introduction of the manufacture of brass, and was accomplished by Elizabeth granting to William Humfrey, "say" Master of the Mint, and to Christopher Shutz, an "Almain," born at St. Amien Berg, under the obedience of the Elector of Saxony, a patent for working Calamine stone and making Brass. Shutz is stated, in the quaint language of the period, to have been a man "of great cunning, knowledge, and experience, as well in finding of the calamine stone *(i.e.,* ore of zinc,) as in the right and proper use thereof, for the composition of the mixed metal commonly called 'latten,' viz., brass, in reducing it to be soft and malleable; also in apting, manuring, and working the same into all sorts of battery wares, cast work, and wire." The patent, which secures to Humfrey and Shutz the exclusive right to practise the mining for zinc and the manufacture of brass, bears date the 17th September, 1565, and from it may be traced the rise of the manufacture of brass in this country. With the intention of further encouraging metallic and chemical industry, on the 28th of May, 1566, Queen Elizabeth granted additional letters patent to Humfrey and Shutz, in addition to those previously granted to Cornelius de Voz, for getting alum and copperas, and divers "ewers" of metals; and to Houghsetter and Thurland, for getting gold, silver, copper, and quicksilver; and they, with the Lord Chancellor, and other principal Ministers of State, to be Societies of the City of London, by the name of Governors, Assistants, and Societies of the City of London, of and for the Mineral and Battery Works. Humfrey and Shutz had, however, an exclusive grant for the sale and proper use of the calamine stone. These patentees and the Society held unlimited sway in things mineral and metallic. They gained additional privileges from James I., in 1609; Charles I., in 1631 and 1639, and from Charles II., in 1668—in whose reign the several interests of the heirs and successors of the patentees already named were merged into one sole and entire united company, bearing the title already given. It had its Corporate Seal, had a Mineral Master General, in addition to other officers; held Courts, let, and set mines, and up to the year 1710, at least, continued as a power in the industries within its province. No doubt, in the early stage of these industries, its influence was beneficial; but it ceased to be so when private enterprise took the place of national patronage, and mines passed from being national, or the property of the monarch of these realms, into the hands of the private smelter.

During the reigns of James I., and Charles I. and II., the manufacture of brass appears to have been practised with varied success, and the manufacturers, like all who but recently had embarked in new undertakings, appear to have been harrassed by the importation of foreign products of a similar kind to those produced by them; they, therefore, adopted a Conservative policy, and petitioned that foreign imports in brass should be prohibited, or the import duty thereon increased. In 1625, the copper of the King of Sweden was specially singled out for increased duty, as "the Swedes had determined to sell their goods at a loss, in order to undersell those of English manufacture." Brass wire was then selling at £8 per hundredweight, but the introduction of Swedish wire had reduced it to £5 5*s*. "If the introduction of Swedish wire was not prohibited, or the duty largely increased, it was alleged that the suspension of labour in the calamine mines of Somersetshire, &c., and the copper mines of Wales, must follow as an inevitable consequence. The continuance of the brass works, it was held, was of the utmost importance. In 1639, a further extension of the prohibition was asked for, and obtained; the petition sets forth that, before the year 1665, there was not any wire made or drawn by such devices, tools, or engines, as were devised by Humfrey and Shutz; before which time all English wire was made and drawn by "man's strength." The precarious and fluctuating nature of the brass trade, as indicated by what has been already stated, does not appear to have hindered other manufacturers entering the field. In 1649, Jacob Monimia and Daniel Diametrius, both Germans, established brass works at Esher, near Surrey, on which they expended the sum of £6,000; but which, after being in operation thirty-four years, and making good profit, they were compelled to give up working, to their own ruin, and, as they expressed it, to the prejudice of the kingdom, in losing so beneficial an art—having here, *i.e.*, in England, the best copper and calamine of any part of Europe. Battery works, however, were being rapidly extended even in the face of the failure alluded to. An ancestor of Lord Byron leased brass battery works at Nottingham, at a rental of £400 per annum. Daniel and Joseph Houghsetter (descendants of the Houghsetter named in Queen Elizabeth's grant) were working the Goldscope Copper Mine, near Keswick, and were licensed to convert the copper found into brass. This mine, reputed to be very rich in copper, at which 4,000 artificers and labourers were employed, in the Cromwellian wars of 1650 and 1661, had its smelting houses destroyed, its working put a stop to, and most of its miners were killed or followed the Protector. The working was resumed by Dutch miners, brought over by William III.; they were driven from it in 1715, and no effort has since been made to resume operations. The mouth of the level, surrounded by heaps of grass-grown *débris*, serves to mark the spot where thousands toiled, "and mines existed so valuable that they served the whole kingdom."

The Battery Works, as might be supposed, were not confined to the production of articles in metals: they embraced the production of chemical substances, with the exclusive right to get the raw materials—the production of glass, colours of all kinds, oils fit for the lamps of princes and noblemen, enamelled and other earthenware, &c., rock and various other mineral salts, &c. As regards the strictly metallic department of the battery works, an enumeration of their varied products cannot fail to be particularly interesting after the lapse of 160 years, as it indicates the condition in which the raw material was supplied to manufacturers engaged in the industries in copper and brass; besides, we gather from it a knowledge as to the existence of processes and mechanical appliances at a much earlier period than we of the present generation could have anticipated as likely to have then been practised. The products of the battery works were as follows :—"Copper battery plate, copper hoops, copper rods, copper wire, fine brass or "latten" battery plate, ditto in sheets planished; ditto in hoops, in rods, in wire, in pins, in sorts, in thimbles, needles, aurichalchum; ditto in sheets, ditto in thin leaves, ditto in wire, fine wire flated for weaving; ditto for knots for head dresses, &c., ditto in leaves for gilding, ditto in shells for painting and writing, commonly called shell gold; lead in sheets, strained by water engines; rolled tin in leaves, for foils for looking glasses; metal colours in powder." The term "Battery Works" suggests that one establishment in Birmingham—*i.e.*, that of the late Mr. Benjamin Gibbons, in Digbeth, (now conducted by his sons)—still bears that title; its commencement, however, was within the present century; it had no connection with any of the old establishments whose name it bears, though some of the articles manufactured are produced by the same processes, as neptunes, guinea pans and kettles, Lisbon pans, &c., viz., that of "battery," or hammering.

The making of brass at Bristol is an important link in the history of the progress of the brass manufacture in England, and as from it Birmingham received a portion of its supply in the early period of her brass manufacture, an allusion to what was done there cannot fail to be interesting.

Brass works were established at the Baptist Mills, near Bristol, early in 1700, by Mr. Darby, an ancestor of the present Darbys, of Coalbrook Dale, and by a Mr. Lloyd, from North Wales, who carried on the manufacture of brass under the name of "The Bristol Brass Battery Company." At these works were made ingot brass, battery-work, and rolled brass, the "strips" for the latter being cast in two ingots formed by granite stones, and afterwards beaten or rolled out.

In a few years after the establishment of the Baptist Mills Works, they were transferred to other parties, and the style of the firm altered to that of Joseph Loscombe and Brass Works Company, who immediately proceeded to erect other works in the neighbourhood, viz., at Keynsham, Kelson, Salford, Weston near Bath, and Warmley, and they erected three hammer mills on different parts of the river Chew. At Keynsham they had rolling mills and wire mills, and at the other works hammer mills for battery work.

All the foregoing works were carried on by Joseph Loscombe and Brass Works Company for nearly fifty years, they were then taken to by a new firm, composed of three or four of the family of the Harfords, a Sir Jarret Smith, and a Mr. Battersby, who styled themselves "Harfords' and Bristol Brass Battery and Wire Company." These works were all carried on for the manufacture of brass for more than a half century, since which the majority of them, one after another, have been discontinued. The works at Weston, and the two mills on the river Chew, were discontinued about fifty years ago. The mills at Weston are now used for grinding logwood, and the two upon the river Chew, one for cement and the other for flour.

The Baptist Mills Works were discontinued about thirty-five years since, and are now used for pottery purposes. The mills at Kelson were abandoned about twenty years ago, and are now in ruins.

The works at present in operation for the manufacture of brass in the neighbourhood of Bristol are those at Keynsham, Salford, and one of the mills on the river Chew. The Bristol brass was originally made from copper and calamine, the latter being obtained from Shipham, on the Mendip Hills, a distance of about sixteen miles from Keynsham. For the last twenty-five years spelter has been substituted for calamine.

The production of brass in the neighbourhood of Bristol, during the last fifty years, has certainly diminished more than one half.

The partners of the firm of "Harfords' and Bristol Brass Battery Company" have changed several times during the present century; lately all the old partners have gone out, although the style of the firm remains the same, the present company consists only of Messrs. Henry Elford, Donald Bain, and Alexander Steed, the two former having been in the service of Messrs. Williams, Foster, and Company. The "Harfords' and Bristol Brass Battery Company" commenced copper smelting in the neighbourhood of Bristol, at Crews' Hole and Conham, about a century ago, and continued to manufacture copper for general sale and the use of their brass works for upwards of fifty years, having discontinued copper smelting early in the present century.

They rolled copper at their mills at Kelson, and had also some copper mills at Bitton, but discontinued rolling copper soon after they discontinued smelting. In 1710, the right to work for copper and convert it into brass, as regards Ireland, was granted to one Thomas Oswin, whose works were erected in the vicinity of Dublin.

The progress of the manufacture leads us nearer home, to Staffordshire. Cheadle brass was also celebrated, and from it, as from Bristol, Birmingham drew a portion of its early supplies. The Cheadle Copper and Brass Company first commenced operations in 1717, when they erected copper smelting works at Bank Quay, near Warrington. I have heard my father say, (writes W. H. Keates, Esq.,) that the first entry in their books was characteristic—"Paid for ALE, to men digging foundations." Originally all the copper they used in making brass was smelted at Bank Quay.

The brass works were built near Cheadle, in Staffordshire, soon after the erection of the copper works at Bank Quay—the locality was probably chosen on account of there being an abundant supply of suitable coal, its being about midway between the supply of copper, from Lancashire, and of calamine, from Derbyshire, and its proximity to the river Churnet, at Oakamoor and Alton, which supplied the necessary power for the rolling and wire mills. Originally copper was carried from Bank Quay to Cheadle on the backs of horses, afterwards in waggons, and, finally, by canal. "I recollect," says Mr. Keates, "calamine being brought to Cheadle on the backs of mules from Derbyshire." On discontinuing their smelting works at Bank Quay, they erected others near the brass works, and also at Pencowdd, and Neath Abbey, in South Wales.

From the time of the erection of their works at Cheadle, until about the year 1830, all the brass was made by the old process of cementation, and, probably, at no place in Europe was this process conducted more successfully, or at which brass of better quality was produced. About the year 1830, the old process was discontinued, and the company began to make brass at their rolling and wire mills, at Oakamoor, by directly combining the two metals, copper and spelter.

The furnaces at Cheadle were similar to those used in brasshouses generally, and consisted of circular dome-like chambers, lined with fire-bricks, terminating in a circular flue. At some distance from the bottom, provision was made for setting the pots, nine in number, *i.e.*, a large centre or "king pot," and eight smaller pots—the contents of which consisted of shot copper, calamine, and ground chemical, under each of the pots a flue hole was introduced, which admitted air, and increased the action of the fuel and heat of the furnace. The contents of the eight pots, when melted, were emptied into the "king pot," its contents, after being well stirred and mixed, were poured into ingots. Four such furnaces were placed in each "melting house," the works originally consisted of two such houses—or eight furnaces, which produced about 2½ tons of brass per week, these were gradually increased up to thirty-six furnaces, and the produce of brass raised to about 600 tons per annum. Of this quantity, about three-fourths was converted into wire and sheets—the latter called "latten," and the remainder was cast into ingots of 6 or 7lbs. each.

The brass for wire and sheets was cast into "plates," which weighed from 96 to 100lbs. each, and varied in dimensions from 5ft. 2in. to 5ft. 10in. long, and 11 to 15in. broad. The moulds in which these "plates" were cast were formed of two massive slabs of granite of at least 6ft. 4in. long by 2ft. 9in. broad, and about 8in. thick. One face of each slab was plastered over with fire-clay and loam to give it the requisite smoothness, and strips of iron were inserted between the two slabs to determine the length, width, and thickness of the "plates" of brass, and the whole was then screwed together by machinery, at a proper inclination, to receive the melted metal. The brass intended for "latten" consisted, as nearly as possible, of two-parts copper and one-part zinc—as also did the wire, denominated "pale," used for various purposes; but the wire intended for pins contained a little more zinc, as also did the ingot brass.

Four qualities of ingot brass were made at Cheadle, viz.:—

B B—Made of best copper, and same quantity of zinc as the "plates" for "latten."

B C—Inferior copper, and slightly more zinc.

A M—Some copper and calamine, tainted with lead.

Y Y—Made of ash metal and other inferior materials.

The B C ingots were always broken through the middle, and hence known as "B C, broke."

Wolverhampton and Sheffield took the Y Y ingots—not much of which was made—the latter town also took some B B; the great bulk of all the rest went to Birmingham. Of all sorts, ingots, "latten," and wire, I suppose Birmingham took from Cheadle about 350 tons per annum; the rest went to London, Gloucester, Warrington, and Manchester, principally as wire, for pins.

The quality of copper, for making good brass for sheets and wire, was of the utmost importance in the old process of cementation, and to obtain this, the Cheadle Company, and

Messrs. Harfords of Bristol, prepared it from the ore themselves, on this account, chiefly, the brass made at Cheadle and Bristol was much esteemed.

It is worthy of note, that though various calamines were used—dug from Derbyshire, Flintshire, Somersetshire, and Yorkshire—from long experience and care, the percentage of zinc in the different qualities of brass produced was secured with as much certainty as it is by the method of direct mixture now practised.

In addition to the works at Cheadle, the company had for several years works at Greenfield, in Flintshire, where the brass made was converted into pans by the battery process—(these works were undoubtedly those visited by Matthew Boulton, as will be shown in the history of the Birmingham Brass and Spelter Company, established in 1781, to be introduced hereafter).

The Cheadle Company produced also small quantities of Prince Rupert's metal, known as "prince's metal," composed of equal quantities of copper and zinc, which was rolled into sheets, and drawn into a particular kind of wire, for the weaving of wire cloth, to be used in the webs of paper-making machines, the strings of pianofortes, and other musical instruments, which wire held an intermediate place between ordinary brass wire and that which is now known as "red wire." After the erection of the works at Cheadle, "brass houses" sprung up in various parts of the county. The Coleshill Street Brass Works, in Birmingham, began operations in 1740, and others were erected at Stoke, Macclesfield, and Framilode, Swansea, and Llanelly, the two last named made only ingot metal; the others, in addition, sheet metal, for the production of battery and other works produced from sheet metal.

In the year 1720, *i.e.*, that of the Great South Sea Bubble, additional works for the manufacture of brass were included among other projects of a speculative character; shares of the Temple Brass Works, situated on the River Hackney, near London, originally established under the patronage of Prince Rupert, and celebrated for the production of prince's metal, brass guns, &c., on which the sum of £10 per share had been paid, realised in the Change Alley £250 per share. The success of this scheme induced the projection of other companies for "the improving of English copper and brass;" these, however, appear to have shared the fate of numberless projected companies which in so peculiar a manner distinguished that eventful year.

In the following year, 1721, William Wood (a leading iron master who undertook the coinage of the copper halfpennies for the kingdom of Ireland, which he executed in so inferior a manner as necessitated their being called in, and for which, in the celebrated "Drapier Letters" of Dean Swift, he received a severe and merited castigation) issued a pamphlet by which we learn that not fewer than 30,000 individuals (probably an exaggeration as to numbers) were employed in the manufacture of brass, *i.e.*, as miners of copper, and calamine, in the mills for rolling, wire drawing, &c. It was refined by pit coal. "The abundance of *lapis calaminaris* and copper, to be found in many counties in England, Wales, and Scotland, was set forth, therefore the nation could supply itself with its own brass, if such duties were laid on foreign copper and brass as would discourage their importation, and at the same time encourage the sale of English metal."

Having disposed of the early history of brass, glanced at the introduction of its manufacture into England, and where it was made, the progress of the brass trade in Birmingham will now be entered upon.

About fifty years after the introduction of the metal into the town (or of "Hutton's First Brassfounder") as we have stated, the demand for raw material was such as to induce the Turners to start a brass house in Coleshill Street. Unfortunately we have no record to guide us as to the kind of brass articles first made—no doubt they possessed all the peculiarities and defects of articles produced at an early period of a new industry; in all probability there was queer fitting, abundance of material, their finish imperfect, of form there was little, of ornamentation less, the patterns were imperfectly made, as the numbers required to be cast therefrom were small in comparison to what is now required, the tools at the command of the workman were few and imperfect, and manual labour alone was employed; the era of "power" had not arrived, and the division of labour, which marks an advanced era in manufactures, was then not understood. The position of the brass trade between 1689 and 1760 was that of making only—it had not reached the dignity of manufacturing—the former epithet referring to the production of a *small*, the latter to that of a *very much larger number of individuals.* The then industry of Birmingham was, as has been well said, "of a staid and steady character;" while the fame of the brass articles produced had even, in those days of imperfect roads and limited means of transit, reached many of the larger towns of the empire; the manufacturers remained at home and let the orders come to them; customers did come, and brought with them, not three or six months' acceptances to pay for their purchases, but produced the cash from their saddle bags, paid for what they had, and took their limited purchases away in the same receptacle, or, if too bulky, had them forwarded by the first carrier's van, drawn by four horses.

The era of travellers and blue bags had not then arrived, Oak brass-bound boxes, filled with pattern cards, on which are displayed samples of the articles made by the house represented, had not then been called into existence; and of pattern books, folio in size, with representations of the articles "done," in all the glories of chromo-lithography or copper-plate printing, there were none.

With improved roads and means of conveyance, the Birmingham brass trade grew; then came the era of Inland Navigation, and the genius of Brindley appeared upon the scene. A canal, cut in the year 1768-9, connected the collieries of Staffordshire with the furnaces of Birmingham; the town being in the centre of England, other branch canals speedily opened up communication with Gloucester and Bristol on the one side, and through the Trent to Gainsborough and Hull on the other; all tended to reduce the cost of conveyance of raw material, and that of the carriage of finished articles to their destination. Still, however, Birmingham manufacturers lacked that which kings covet, "power," in plain words, they depended entirely on manual labour for the production of their articles, and on other localities for their chief supply of ingot, sheet, or rolled metal; the water supply in the immediate vicinity of the town was poor, and the genius of all-conquering steam had not as yet dawned in Birmingham. It is true, that in 1700 a Rolling Mill, driven by the limited water power at command, existed down at the Nechells; and in 1756 another was set in motion by the diversion of the waters of Hockley Brook by means of a cutting, half a mile in length, and the formation of the lake at Hockley (which still exists), the head of water from which drove the rolls in a somewhat feeble mill erected below; eventually the lease of this mill and the surrounding property passed from the then lessee, Mr. Edward Rushton, to Matthew Boulton, and then the height above the lake named, was crowned with the once world-celebrated Soho Manufactory. At Dog Pool, in another direction, there was also a rolling mill driven by water, and the waters of Edgbaston Pool gave motion to a fourth rolling mill at Edgbaston; very soon, however, Birmingham men appear to have learnt that water power of so feeble and uncertain a kind as it is in their locality could be but little depended upon, and the first who seems practically to have obviated its use was a Mr. Twigg, who erected, in the year 1760, an infant steam or "fire engine," on the principle of Newcome and Cawley, on the premises in Water Street now occupied by Mr. P. H. Muntz. Boulton, at the Soho, erected a similar engine for a similar purpose, *i.e.*, that of metal rolling. In all probability observations on the defective working of that engine led to his appreciation of the invention of James Watt, and eventually led to the partnership of these two celebrated men. The Phipsons had a "fire machine," erected at a somewhat later period in Fazeley Street, at the mill now in the occupation of Mr. Clifford; the engine was, after its erection, improved or re-modelled by Boulton and Watt; and there was yet another, belonging to the New Mill Company. Allusion is made to the erection of rolling mills, as the period had arrived when, in the brass trade, their operation was of the utmost importance, for in 1769 the process of producing brass articles by means of the stamp and die was introduced, and the era of Stamped Brassfoundry began. Previously, all articles in brass had been cast; the new process, the cheapness of the articles, in comparison with those produced by casting, and their superior finish, gave an immense impetus to the trade, and all the more that the sheet brass from which they were produced could be had in the town by means of the rolling mills named, thereby obviating the necessity of sending for it to Cheadle and Bristol, from whence Birmingham manufacturers had previously received their supply of metal in that form, as has been already stated.

Mr. Twigg's "fire-engine" may again be alluded to, as it refers to, and marks the introduction of "Power to Let," for, in addition to giving motion to four pairs of rolls, which was the purpose for which it was erected, he was the first to let out his surplus power, by the erection of premises through which shafting was conducted, the rooms being rented at so much per week by small manufacturers or workmen who were unable to erect small engines for themselves, owing to their limited means. In Bailey's Directory, of the year 1783, we find the following advertisement:—"Charles Twigg and Co., Rollers of Metal, Grinders and Borers of Gun Barrels, at the Steam Mill, Snow Hill. N.B.—This mill is erected for the above purposes, and also for the polishing of steel goods, finishing buckles, buckle chapes, and a variety of other articles usually done per foot lathes. The whole is worked by a steam engine, and saves manufacturers the trouble of sending several miles into the country, to water mills." "Power to Let" accommodation, though still taken advantage of by many of the smaller trades of the town, is only exceptionally so now by brassfounders, and by those of limited means; almost every small brassfoundry has now a steam-engine of its own erected on the premises, which gives motion to lathes and other appliances, to facilitate the execution of the work.

In 1780, Hutton placed the consumption of brass at 1,000 tons per annum in Birmingham—in all probability this was only an ideal approximation—it may, therefore, be said to have consumed about 650 tons of copper; thirty times that quantity, or nearly what may be stated at 20,000 tons, independent of old brass reconverted for use, is now annually consumed, or was in the year 1865.

In 1780 occurred one of those episodes in connection with the copper and brass trade, which have, more or less, during the last eighty-four years, harrassed and perplexed manufacturers of brassfoundry. The production of copper in Cornwall and Devonshire, which, in 1771, amounted to 3,347 tons, of the standard value of £81 per ton, fell in 1780 to 2,932 tons, and the standard rose to £83 per ton. As copper is the chief element in the composition of brass, it was (brass) advanced £12 per ton, viz., from £72 to £84 per ton. At £72 per ton, copper being £81, brassmakers were realising, in clear profit, £12 6*s.* 8*d.*, or nearly 15 per cent. per ton, after all expenses of material, wages, wear of furnaces, &c., were paid; at £84 per ton, (there had been only £2 per ton advance in the copper), copper being £83; zinc or calamine ore, coals, and labour remained the same, they (the brass makers) realised about £18. 13*s.* 4*d.* per ton, and gained 25 per cent. The brassfoundry trade was taken at a disadvantage; up to that time nothing had disturbed the even tenor of its way. It was a growing trade, rapidly approaching the dignity of a manufacture; the one brassfounder of the reign of King William had increased to upwards of thirty—many of them men of wealth, and leaders of what were then considered large works. They met in conclave at "The Swan," and issued a notice, of which the following is a copy, interesting as it records the names of the chief brassfounders eighty-six years ago. It was as follows (and suggests, by the expression, "advance of seven and a half per cent.," that brassfoundry goods were then sold at net prices):—

Birmingham, August 28, 1780.

BRASSFOUNDERY.

At a Meeting held This Day, at The Swan, in Bull Street, we, whose Signatures are here annexed, in Consequence of the late Advance in the price of Ingot Brass, find ourselves under the disagreeable Necessity of advancing the Price of Brass Foundry Goods, Seven and a Half per Cent.

Timothy Smith,
Samuel Parker,
William Wheelwright,
Thomas Underhill,
John Barker,
Townshend and Longmore,
John Simmons,
Richard Webster,
Charles Power,
Smith, Cocks, and Taylor,
Grew and Sheriff,
John Rotton,
Whitworth and Yates,
Price Pritchit,
Atkins and Longmore,
Boole and Barber,
William Lowe,
Richard Beach,
Thomas Smith.

The crisis alluded to, which called forth the advertisement, those familiar with the pages of Hutton will have no difficulty in identifying with the paragraph which is now introduced, viz.:—

> "In 1781, a person, from affection to the user, or resentment to the makers, perhaps the *latter*, harangued the public in the weekly papers; censured the arbitrary measures of the brazen sovereigns; shewed their dangerous influence over the trades of the town, and the easy manner in which works of our own might be constructed; good often arises out of evil: this fiery match, dipt in brimstone, quickly kindled another furnace in Birmingham. Public meetings were advertised, a committee appointed, and subscriptions opened to fill two hundred shares of £100 each, deemed a sufficient capital; each proprietor of a share to purchase one ton of brass annually. Works were immediately erected on the banks of the canal, for the advantage of water carriage, and the whole was conducted with the true spirit of Birmingham freedom."

Being anxious, if possible, to ascertain the nature of the "harangue," on searching the files of *Aris's Gazette*, it was there discovered. As it is a very extraordinary document, of a thoroughly patriotic character, conceived and written in the language and peculiar phraseology of the period, by permission of the proprietors, it has been copied, and is here printed in extenso. The writer, as it will be seen, contends manfully for the exalted position which the brass trade had even then reached, after barely one hundred years from the date of its introduction. Let the "harangue" speak for itself, it is as follows, and is designated by the writer as—

A Serious Address to the Merchants and Manufacturers of Hardware, and particularly the Inhabitants of BIRMINGHAM and the adjacent Towns.

GENTLEMEN,

Suffer me to call your attention to a few Strictures I take the liberty of making upon some late Incidents respecting the articles of Raw Metals, matters that so essentially concern you, that I am much astonished that no one has stepped forward to explain them, and show the injury you sustain, and the dangers your manufactories are exposed to by the same.

I should have been happy in seeing some more able pen employed in this business, but rather than Sentiments should lie longer obscure (that I am persuaded are held by almost every individual), and not communicated in general to each other, I have taken the Liberty to give you mine at large, in Hopes it may excite you to take them into Consideration, and rouse you from all supine neglect to a State of active attention to your Interest and Consequence, which can best be effected by carefully guarding the grand source—I mean Raw Materials.

The Consequence of this kingdom exists in its Manufactures, and yours are a large and valuable Part in the Scale of Commerce. You have surprised all Europe in Invention and Execution; you have sought Honour and Profit, and it has been found in every Quarter of the Globe. Nothing then can be so essential to you as the Maintaining and Improving such well-earned reputation. Your competitors in other nations are jealous of your superiority, and, with unwearied attention, watch every opportunity to share with you a trade they cannot equal, much more excel, and yet often partake materially of, from the too frequent fluctuation of Prices, owing, I presume, to the unsteady state of Raw Materials, the which I conceive to consist principally in Iron, Brass, Copper, and Spelter; all others may be considered subordinate to them. As for Iron, the Amount is so small in comparison with Copper, Brass, and Spelter, that the fall of 20*s.* or even 40*s.* a ton (and more it seldom undergoes) does not become a grievance, since the London, Bristol, and Hull Markets live and continue to supply you with the fabricks of the Black Country, that moderates that Article, keeping down the price of English Iron (which might otherwise be very high), and leaves you without Complaint, especially in the finer Branches. It is not so with Copper and Brass; therefore to that very considerable and consequential, and of Raw material so necessary to your manufactures, I wish more particularly to call your attention, while I endeavour to point out to you the late absurd Conduct of the makers of Copper and Brass, and the dangerous tendency they have to your manufactories. Advance upon any articles should ever be avoided until necessity obliges, for variety of reasons, and Falls should be as carefully made, and not before all Circumstances evince the propriety, and that no local inducements can create a speedy Advance; in such case they are of benefit in General. But, on the contrary, when a Fall is made without intention of stability, it deceives and becomes a real injury, as is fully felt upon the recent Advances upon Copper and Brass, after the strongest assurances that circumstances would render the former Falls permanent, in consequence of which you generously declined taking the Advantage to yourselves, but as a body emulous to promote the reputation of your Manufactories, you gave those advantages to the public, by lowering your prices or increasing your discounts adequate to the various Falls upon Copper, Brass, and Spelter; the Consequence of which is that, from the avaricious disposition of some, the capricious conduct of others, with a combination of the whole body of makers of Copper and Brass, they attempt to avail themselves of an Extraordinary advantage, by imposing on you an enormous Advance of more than twenty pounds per ton on Copper, and upwards of thirteen pounds per ton on Brass, without any other reason than that they presume to reckon on Their Power under such Association, and that the same must and will be received tamely by you. From this unexpected and wanton Stretch of Power, thousands of industrious artists, who are not able to raise the articles they have fallen, at once lose the profits of their Labours, at a Time they were so ably contributing to the Honour and Support of their various Branches. This naturally leads me to descant on the Motives that incite the Makers of Metals, and request you will take a Retrospective View of their Conduct during Your own experience, and you will be convinced that Avarice and Power were predominant Passions by which they have been governed, and to which you have for a long Series of years submitted; in the infant state of your Trade, you are shackled with Difficulties to which it was prudent for you to submit, because Industry and Prudence alone would soon free you. That happy period has long been arrived: you are emerged from every Degree of Dependence, as a Body numerous and Wealthy, who have rendered yourselves honourable in employment—the pride of England, and Admiration of the World. With such well-deserved Consequence, shall a few designing Men presume to insult you, and arrogate to themselves a Right of dictating to, or restraining your free Inclinations—by monopolising, confederating, and prescribing Regulations, as despicable as they are weak and absurd? In former years the Company (now called the O. C.) assumed the Whole controlling Power; they rose and fell prices at Discretion; but as all persecutions beget Resentment, so Resentment creates Opposition, and Opposition produced Adventurers not in the least intimidated by such formidable Powers. So boldly stood forth the Champions of Liberty, and, in defiance of Oppression, ventured to erect works and risque their Fortunes therein; but such (to the O. C. presumptious intruders) had dared to withdraw themselves from their Power, so they became Victims marked for punishment—no less than total Ruin. Prices were lowered upon them, to that Degree calculated to sink their works, and make their fate inevitable; no matter if it cost the Company £10,000 or £20,000, that sum could be realised on a future advance, when Opposition was removed. Witness Mr. Turner's brass-house, and the many Falls they have made upon his infant trade, and which must have been crushed but for the Protection of the Warehouses. Again, when the new Company at Birmingham had erected their works, the price was reduced at three different Falls fifteen pounds per ton; and afterwards, Mr. Emerson building a spelter house, they fell that Article from £74 to £48, and under. Such was their Mortification when any rival presumed to set up in Opposition against them; your Patronage and Support preserved their works, and convinced the O. C. that Measures must be changed, and new Modes of enslaving adopted; accordingly, this very Company, who so lately endeavoured to destroy their Works, condescended to court a Reconciliation with their Opponents, who have been persuaded to enter into a grand League, for the sole Purpose of advancing Metals. What a strange Fatality must attend those Men, who could so inconsiderately desert their Protectors, forget every Obligation, and combine with a Company who so recently pursued them for Destruction. But ingratitude is no Foreign Exotic, it springs spontaneously in every Clime.

The great Consumption of Metals in the manufactories of Birmingham undoubtedly lies in Brass and Spelter; therefore, Copper being of little Consequence, it is less necessary to erect works for that Purpose; but where it is considered the latter to be the principal Metal in making the former, you see the Necessity there is to build a small smelting-house or Copper Works for the Purpose of making such quantity only as will be used in the making of Brass. Besides, the present Advance upon Brass (no way proportionate to the rise upon Copper) Points out a further Necessity to make it, towards the Disadvantage which the makers of Brass only are subject to; from hence may be seen the Implacability of the O. C., for though a Union has been made with the Works at Birmingham, the present price of Brass shews them they are yet unforgiven, and may one Day or other become a Sacrifice to that Power which only wants an Opportunity to be enforced.

The first production of this wonderful Coalition was the enormous Advance, before mentioned, on Copper and Brass (as for Spelter, that at present remains reduced, not having lost all Hope of annihilating Opposers in that Article, and recovering back their former Monopoly). The Second Fruits were Regulations and Restrictions. The O. C., with singular Indifference and Ingratitude to their Old Friends, establish One Single Agent at Birmingham, to the entire Exclusion of those who had so long and faithfully served them, and open a Warehouse there for the sale of their articles, Wholesale and Retail; not content with this, but flushed with Power, the Associations (who owe their Consequence to your indulgent, fostering Care), with peculiar Rashness, tell you that "If you dare to sell at a less price than they have fixed, you shall not be served at all." Gentlemen, this is such an arbitrary Extension of Power; such a proscription of Liberties that belongs to no set of Men whatever to impose. I appeal to your Feelings as Men, to your Consequence as Tradesmen: Indignation spurns the Idea. Under these alarming circumstances, founded on facts, shall so respectable a Body of Merchants and Manufacturers become the Dupes of a set of Capricious Monopolists in the articles of Brass and Spelter on which their trade depends? No! you must rouse yourselves; tame Submission would be Ignominy. Reflection will bring you to a sense of your Danger, and dictate to you the Expediency of becoming Independent in the articles of Raw Materials; be no longer governed by Strangers when you have the Power to help yourselves at Home; the Path is plain and easy; the making of Copper and Brass is familiar and without Risque; what then should prevent the Merchants and Manufacturers from making their own Metals, by which every advantage may be expected? In Order to accomplish this desirable End, it will be necessary to raise a Fund sufficient for the Purpose, to be divided into shares, and every Merchant and Manufacturer to be subscribers. It may be said, who will conduct the Undertaking? I answer, who so proper as Yourselves. Let a Committee be chosen out of the Subscribers, who shall superintend the Business, with an allowance for their Trouble; and let Power be invested in them to appoint Clerks to carry into Execution the Plans formed by the Committee, you will then be your own makers of Metals; all Combinations against you must fall to the Ground; and though the Monopolists may play their old Game of sinking Prices, to tire out the Concern, what will be more, your Advantage will be found in the Price of Metals; as Manufacturers, Let, therefore, a Meeting be called, and Plans brought for the Design; the Prices of Our Calamy, Coal, Carriage, &c., will be laid before you, and will be but a just Punishment on the O. C. (as Makers and Promoters of every rise upon Metals that has been made for these Fifty years past) for the Manufacturers to unite and subscribe to an article under a penalty, not to use any brass made by them; but however this may be, feel your own Conscience; let Unanimity prevail between the Warehouses and Manufacturers; let no Underhand Schemes separate you—consider yourselves as Men joined in one interest, one Common Cause, by subscribing to a capital of Thirty, Forty, or even Fifty Thousand Pounds, or more, if needful, to be divided into One Hundred Shares, these Shares paid by Instalments, as Occasion requires, and each Share transferable by Sale. This plan I conceive will secure your Manufactories, bring Reputation and Profit to yourselves, and must effectually crush all opposition.

In the infancy of your Trade you are not able to perform a Design of this Magnitude, but the Enlargement of your Concerns, and Success in them, has made you by far more capable to execute such a Scheme than any Company in the Kingdom, and for this plain Reason, because being Makers of Metals, you will find and use your own, consequently your works must stand.

Thus, Gentlemen, I have presumed, as a mere spectator, to throw together a few crude and Undigested Thoughts, upon a Subject I cannot help considering of the utmost Importance to you, and a zealous Well-wisher to the Manufactories of this Kingdom, and of yours in particular. It would give me infinite Pleasure should they be in any Degree productive of furthering the Completion of your perfect Independence in the Articles of Copper, Brass, and Spelter.

I am, truly and faithfully,
Gentlemen,
Your humble Servant,
BRISTOL.

Extracted from *Aris's Gazette*, October 9th, 1780.

The "Serious Address" seems to have had some effect, and the result was, that on the 21st November, 1780, the following advertisement (evidently written by the writer of the address) appeared in the *Gazette*:—

"*To the Merchants and Manufacturers concerned in the consumption of Metals in the town of Birmingham and places adjacent.*

"GENTLEMEN,

"You are earnestly requested to meet at the Hotel, in Temple Row, Birmingham, on Tuesday, 28th November inst., at Three o'clock in the Afternoon, to deliberate on a plan and to enter into a subscription for forming a Company among yourselves for the making of Brass, &c., for your own Consumption, agreeable to the Design proposed to you by that friend to your trade, who addressed you in this paper of Monday, the 9th of October, and thereby to relieve yourselves from the Imposition of a set of mercenary men whose machinations manifestly tend to the Injury of the trade of your Town and Neighbourhood."

The strife seems to have been continued, and "no surrender" was the order of the day. The metal dealers refused to supply the local warehouses where brass was sold, and appointed special agents, the Harfords, of Bristol, then a leading house in the brass trade, advertising the appointment of one Joseph Sheldon as their agent, on the 20th November, 1780. A preliminary meeting was held on the 28th November, according to the advertisement, and the consequence was, that the idea of forming a new Brass and Spelter Company was decided upon. An interim committee was appointed two months thereafter, *i.e.*, on February 2nd, 1781; and we learn that, "on Friday, at a respectable meeting of the principal Merchants and Manufacturers of this town, respecting erecting a Brass Works in order to relieve the manufacturers from the uncertainty of Brass, from the Report of the Committee, a subscription was opened for the purpose, and the sum of Twenty Thousand Pounds subscribed for its execution."

It is singular to remark that Hutton, with his great talent for collecting gossip, should have failed to ascertain, or if he ascertained, did not record the fact of Matthew Boulton's connection with the new company in the early part of its existence; yet Boulton was the "guide, philosopher, and friend" of the shareholders in the difficulty in which they felt themselves placed. Was Matthew Boulton the writer of the "Serious Address:" did he plan the company, and knowing that, did the shareholders ask his aid?—as they did, and as we will presently show—or did they recognise in him a "power" which could alone help them to wage the unequal war? At the period named, Boulton had erected, at that time and for fifty years thereafter, the unequalled Soho manufactory, of which, alas! no traces remain, save heaps of débris and grass-covered mounds, to tell where hundreds toiled, where the steam engine was perfected, and from whence issued the coinage of the nation. Seven years previously, he had formed a partnership with James Watt, already their patents were being disputed and infringed, law proceedings were pending, and the issues of these trembled in the balance. In addition, Boulton had to attend to that department of the Soho peculiarly his own, to the production of costly works in precious and plated metals, to clocks ingeniously constructed and with ornamental cases, to fine art bronzes and articles in ormolu, to filagree work, buttons, buckles and clasps, lamps, brackets, candlesticks, and tea urns; improvements in the process of coining were engaging his active mind; he was a large producer of rolled metals, and the occasional bad health and despondency of Watt formed no small part of his anxieties, and troubles; to crown all, there was his banker's balance against him, but, as has been well said by Mr. Smiles, "he was a noble, manly man, a true leader of men, lofty-minded, intelligent, energetic, and liberal; he was one of those who constitute the life-blood of a nation, and give force and dignity to the national character," being so, when his fellow townsmen called to him, he responded to their call, and though he declined the office of the chairmanship of the Birmingham New Brass and Spelter Company, as will be shown, he gave good, excellent, and important advice for which, as the sequel will show, he was repaid with the basest ingratitude.

The true history of the New Brass and SpelterCompany which arose out of "the arbitrary measures of the brazen sovereigns" of the year 1780, of "another furnace kindled in Birmingham," according to Hutton, is as follows:—"The manufacturers of brassfoundry goods in Birmingham were dissatisfied with the apparently to them, inexplicable advance made by the metal merchants, of £12 per ton on brass, viz., from £72 to £84, and they proposed to start a new company; they wrote to Mr. Boulton, then in Cornwall, on the subject, asking him to take a leading part in it, and if so, they offered to raise the sum of £60,000. He tried to dissuade them, pointing out as the cause of the advance, that the mines were badly and unsatisfactorily worked; the miners preferred to work for tin in preference to copper; the absence of efficient pumping machinery to drain the mines increased the difficulty of working them; "if, however, they determined to proceed after considering his letter, he offered them his assistance and advice." This correspondence Boulton showed to Mr. Wilson, of the Chase Water Copper Mines Company, where he was then superintending the erection of an engine; at the same time he expressed, as his wish, if the New Brass and Spelter Company was formed, that he would, if possible, induce it to purchase the copper used from the Chase Water Company, which he would undertake to enable to produce such quality of copper as would be best for making brass to be used in the Birmingham trade; he then proceeded to sketch out a scheme for the new company—its capital to be not £60,000 but £20,000—no person to hold more than four shares; every holder to covenant to purchase from the company one ton of brass per annum for any share held. From this may be gathered some idea of the limited extent of the consumption of brass in 1781 as contrasted with what it now is in 1866. The scheme issued by the new company was generally approved of, the share list filled, this Boulton saw, and then regretted he had not extended his list of subscribers to embrace 300 instead of 200; as the Company was intended to embrace consumers only, the sale of 200 tons of brass would have been secured. He then suggested that tenders for the supply of copper should at once be invited, and those accepted which were most advantageous, he only asking as a return for his labours, that in the event of equality in price, he should be permitted to decide in favour of the Chase Water Company. The superiority of its copper and its power of supplying with regularity appear to have formed his grounds of preference; that favour, he says, "is all the reward I shall expect for correcting the errors of the Brass and Spelter Company, and leading them to make such brass as I know suits best the different branches of the Birmingham brass manufactures." In furtherance of his desire to aid the New Brass and Spelter Company, he, in visiting Shropshire, extended his journey to Holywell, in Flintshire, and examined the calamine mines there, for in the then state of the metal market the new Company "had reason to suspect that the sorts of calamine known to make the best Bath brass would be attempted to be monopolised," and he further enlightens us by stating that the best "Bath metal brass made in any part is the best Cheadle, and the very best Cheadle brass is made only with Flintshire calamine;" he tells us that the best Cheadle brass was not made there, but at a brass house near Holywell. Certain predilections on the part of manufacturers existed as to Bath metal being made best from Derbyshire calamine; this opinion he combated, maintaining the superiority of the Flintshire ores of zinc, and also the consideration that the freight to Swansea, which he held was the proper place to erect the brass house of the new Company, was cheaper than the freight from Mendip, in Derbyshire. So minute was he in his enquiries, that he names the cost of carriage per ton from Holywell to Swansea into Bristol as from 11*s.* to 12*s.* per ton; and the price of the ore as from £4 4*s.* to £4 10*s.* per ton. He thought the Holywell ore of better quality, and, as a precautionary measure, had settled a correspondence with a man who used to buy for the old company, who could procure any quantity. He brought home, on his return, specimens of the ore for trial, and put himself to some trouble to get a sight of Mr. Hind's brass furnace, but failed in the attempt; on this head he remarked, "ignorance and mystery always accompany each other." He would have built a furnace at the Soho to test the various kinds of calamine and their fitness for making brass but for the pressure of his own business, for he justly maintained that if the quality of the brass produced by the new Company was not good, "contracts ever so favourable would be fruitless."

At this stage of progress in the formation of the Company a hitch occurred; large consumers of brass were disappointed by being excluded from participation in the new Company, and Boulton began to fear that another Company would be formed, and joined to one already established, the operations of which the new Company was intended to control. He used all his eloquence to induce the latter to extend their share list, but in vain, the base of the new Company he said, if they extended it, would thereby be rendered solider and sounder. A meeting was held to consider the possibility of extension, but Boulton's well-meant intentions were defeated; shareholders came and brought with them proxies of others absent, "and the very men who, a few days before, were struggling to emancipate themselves from their oppressors, changed their note; a bonus of £5 per share had been offered, they would not consent to have the concern extended, or the number of shares increased." Fothergill, the partner of Boulton, wanted only four shares, but even this the shareholders would not agree to, and, as was remarked by Boulton, "Congress-like, after obtaining power, they showed a disposition to exercise it to their own advantage only."

A few days after this extraordinary display, with the unpleasant effects still upon his mind, we find Boulton still aiding in the work, and in a letter to a shareholder (Mr. Capper), instructing him how to proceed in getting a good manager, not an ornamental appendage, but a thoroughly practical man, one who knew his work and would do it, of good character, intelligent, and well up in the metallurgy of copper and the making of brass. He was to find security, workmen and coals, with every other expense; the copper and calamine alone to be found by the Company, the remuneration of the manager to be paid by a royalty of between £5 and £6 per ton for every ton of brass produced. He further gives the proportions that for every two tons of copper and three tons of prepared calamine he should be required to return three tons of brass. By adopting these suggestions, says Boulton, "the Company will be placed on a certainty as regards expense, will have no clerks to pay, will be exempt from frauds, thieves, and all other risks." He would not object to teach such manager the way to make best Bath brass, but would object to teach two hundred workmen; he had hoped the Company would retract their rash decision at the last meeting, and "will yet act according to common sense;" he dissuaded shareholders who held his views from selling out. In the selection of a place to erect the new brass-house, he differed from the majority; and held that Swansea, and not Birmingham, was the proper locality—this he had arrived at from calculations made by himself and from other considerations, among which were, that the moment the foundation was laid in Birmingham of a brass-house, he would consider that the game they were playing against the other brass Companies was lost, smelters in copper would sell brass without profit for the sake of selling the copper it contained, they would thereby be getting money, while the new Company were losing; whereas, if their works were erected at Swansea, in the middle of the copper works, a less dead weight of stock copper would be required to be sustained, and, more important still, if the copper purchased was not of the proper quality, it could be more readily exchanged than if the works were 100 miles asunder; "without good and pure copper it is impossible to make good brass," therefore it was better to correct any error of the kind soon than late. Coals were cheaper in Wales than in Birmingham, and any improvements in the manufacture of brass which might be discovered in practice could be more readily preserved by the Company than they could be in the town wherein it was intended to consume the brass made. Boulton had also an abhorrence of the interference of shareholders dressed up in a little brief authority; anticipating this, he writes, "if the works are erected in Birmingham, the work will be constantly deranged by the interference of 100 blockheads, and, instead of being assisted, will be incommoded by every subscriber that chooses to take an idle walk by ye banks of ye canal." Various letters to friends show how bitterly Boulton felt the ingratitude of those he had joined at their earnest request to help; this, added to his increasing business and responsibilities, eventually induced him to withdraw from all active participation in the Company he had so earnestly and at so much self-sacrifice aided, and by personal exertions assisted. On the 21st of May, 1781, he tendered his resignation in a manly and business-like letter, which is here given, nearly in extenso; in it he justly asserts himself, and by doing so, shows the Company what a valuable colleague they had lost; the resignation was merited by the Company—it was worthy of Matthew Boulton. The letter is as follows:—

In his view the Company had not been conducted on the liberal and laudable principle professed, the hope of carrying out which had induced him to join it. The original shareholders had rapidly closed the subscription list, and excluded from participation persons and firms who would have been large and excellent customers. The premium of £5 per share which they had asked for, and in cases obtained, outweighed with them the public interest, and the prosperity of the trade. The monopolising principle that this Company was instituted to counteract, now infected the new establishment, as much as it had done any of the old ones. "I thought it incompatible with the original motion, and I caused a general meeting to be held in order to rectify the complaint; but the decision of that meeting was against me." Mr. Boulton further held to the opinion he had often urged on the committee, that Wales was preferable to Birmingham as a situation for the new Company's works; and he says, "I could make as good, or even better, Bath metal brass in Wales than is now made in Birmingham, and that without Staffordshire coal, or Derbyshire calamine. I have given you reasons why I should prefer Wales to Birmingham, and I have still other reasons not necessary to mention, as it is not likely you will be biased by anything more that I can say; I therefore decline further argument, or any dispute on the subject. You have followed your judgment, reason, and knowledge, the lights which ought to guide us, and I trust to your candour to allow me to do the same."

The Company had by this time determined to erect their works at Birmingham, and Mr. Boulton had learned that Mr. Capper, one of the shareholders, had retired in consequence—he alludes to the retirement, and says, "I do not presume to dictate, but offer my opinion, based upon some knowledge of the copper, brass, and spelter trades. I was anxious to serve the concern, had taken some pains in forming a plan for the establishment of the New Brass and Spelter Company, have made many essays and metallurgical experiments in seeking out the most notable calamine mines, and getting the necessary information; I have endeavoured to make the plan as diffusive as possible throughout ye neighbouring manufacturers, by extending ye subscriptions; but in vain. I have been made use of, but my advice has been rejected, and I stand single in my opinion. From these reflections, and from the consideration of my own business, which is of importance to myself, and a greater load than I can well sustain, I am induced to follow my own judgment, and Mr. Capper's example, by retiring. Whatever expenses may have been incurred, I am willing to pay my share." This terminated Boulton's public connection with the new Brass and Spelter Company.

The works were ultimately erected by the side of "ye canal," in Broad Street, Birmingham—"Brass House Passage," and the building in front now converted into the offices of the Birmingham Water Company indicates their site. Corpulent tunnels, or tapering chimneys were reared behind, under each of which were two furnaces, which with their complement of eight small and one king pot in each, aided the Birmingham brassfounders in their resistance to the oppression of the "monopolist" metal dealers, and helped them to their supplies of ingot metal. Hutton says, "on the starting of these works, the price of brass, on the part of the metal dealers, was reduced from £84 to £56 per ton." Whether that fall or the reduction in the price of metallic zinc with increased facilities for procuring it, or the production of brass by the direct mixture of metallic copper and metallic zinc, gradually sapped the foundation of the old brass houses, "or the derangement of the work by the interference of one hundred blockheads" hindered its success, it is difficult to say; but when every brassfounder became his own brassmaker, the beginning of the end of the old method of brass making was not far distant.

In the year 1831, the Brasshouse alluded to became the property of the late Thomas Pemberton, Esq., Warstone Lane, who continued to make calamine brass there till within the last fifteen years. The building and land on which the Brasshouse stood in the year 1865 was sold to the Birmingham Water Works Company, and in consequence of the necessary alterations required, the last of the six stout, square, tapering chimneys was demolished on the 27th January, 1866. With the operation of this Brasshouse the manufacture of calamine brass terminated in Birmingham; the Brasshouse at Smethwick, which is still standing, having some years previously been diverted from its original intention, and changed into a steel converting house.

Birmingham, which has gained so much celebrity as the seat of liberal principles, whether as regards politics or trade, some three-quarters of a century ago exhibited another phase. In 1783 there existed in it an incipient Chamber of Commerce, designated by the euphonious title of "The Standing General Commercial Committee for the purpose of watching over and conducting the public interests of the town and neighbourhood," and the said Committee engaged in *opposing* a Bill then introduced into Parliament to allow of the free Exportation of Brass. They alleged that such Bill, if passed, might be of the greatest prejudice to the trade and manufactures of the town, and its environs; and, on the 15th July, 1783, we find the Committee of the S. G. C. presenting its grateful thanks to many noblemen and gentlemen who had generously and effectually supported in Parliament the trade of the town, by opposing the passing of the Bill. Some light is thrown on this proceeding by reference to an old Parliamentary Register, wherein we find that on the 17th June, 1783, a Mr. Birkdale, M.P., moved the second reading of the said Bill, which was met by an amendment, moved by Sir Robert Lawley, and seconded by Sir G. S. Shuckburgh (then both representatives of divisions of Warwickshire), that it be read that day three months: the reading was carried by a majority of 22. Mr. Birkdale stated that the passing of the Bill was a necessity, as "hundreds of thousands of pounds paid lay idle, which merchants had expended on the purchase of brass;" in all probability, however, the "Standing Committee" felt justified in opposing the "Brass Masters' Bill" (as it was called) on account of their arbitrary proceedings in the year 1780, which has already been recorded. At a meeting of the S. G. C. Committee already named, held Oct. 8, 1784, we find the Chairman laying before the meeting the startling intelligence showing that, after the 1st November of the year named, the Emperor of Austria had prohibited the entry and the public sale in his dominions of many English manufactures; and he produced the copy of a letter from Vienna, proposing to one eminent manufacturer in this town to bring his people and settle in that country. This incident is introduced in order to contrast the past and present policies in trade matters, as it must be fresh in the memories of our readers that, by the exertions of the present Birmingham Chamber of Commerce, our manufactures are now admitted, or about to be admitted, into Austria, under a comparatively favourable tariff, with the ultimate prospect of a yet lower, or any duty to be paid being finally abolished. "The thoughts of men are widen'd with the process of the suns;" Conservatism in manufactures may be essential in their early stages, or as nations are emerging from a state of semi-barbarism into that of manufacturing communities, to receive from other countries their oppressed and persecuted artisans, and to succour and encourage these is noble, just, and right; and in doing so England has had her reward. (Of course the intention of the predecessors of Austria's Emperor, who holds sunny Italy in his iron grasp, was neither noble nor philanthropic). To the Lollards and the artisans of the States groaning under the iron rule of the Duke of Alva, we owe our manufactures in silk, wool, and glass; to the wise and enlightened policy of Queen Elizabeth, by granting privileges to Christopher Shutz, can be traced our present prosperous Brass trade, whether locally or nationally; the abolition of the fiscal duties on glass raised it into a mighty and gigantic industry, and when the labours of Richard Cobden culminated in Sir Robert Peel giving to this nation "untaxed bread," the days of Conservatism in trade and manufactures, so far as this country is concerned, were at an end.

As one fact is more important than pages of argument, it may be stated that on the Bill allowing the exportation of brass being passed in the year 1799, the quantity exported amounted to 77,033 cwt., or 3,851 tons 13 cwt.; its value at £154 13s. 4d. per ton, or £7 14s. 8d. per cwt., reached the sum of £595,728 15s. 5d. In the year 1864, when brass was very much lower in price, the value of brass articles and yellow metal sheathing exported, amounted to £3,313,406 ! !

SOURCES OF SUPPLY OF THE RAW MATERIALS USED IN THE FORMATION OF BRASS, AS COPPER, ZINC, OR SPELTER, AS IT IS CALLED.—TIN, USED IN THE COMPOSITION OF BELLS, BRONZE, OR GUN METAL.

The sources of the supplies of Copper in this country are the mines of Cornwall and Devon, North Wales, Isle of Man, and Ireland. From these, the greatest quantity is furnished by the Devon and Cornwall mines, which amounts to about three-fourths of this country's produce of Copper; the remaining fourth is received from the other mines already named, the average produce of the mines of the United Kingdom for twelve years being nearly 16,650 tons per annum, the lowest production being in 1865, amounting to 13,000 tons, the highest being in 1856, when it reached 24,257 tons. The home supplies, are totally inadequate to supply the English demand for copper, the quantity required for use in Birmingham alone amounting to nearly 20,000 tons. The estimated consumption of copper over the world at the present time is said to be 90,000 tons, of which England is said to consume or require 60,000 tons; of this is exported in a raw and manufactured condition 37,000 tons, leaving 23,000 tons for home consumption. Of the 90,000 tons consumed in the world in 1865, Chili furnished to England in 1865 48,372 tons. It is curious to remark that whereas the imports from that country in 1854 amounted only to 15,797 tons, in 1865 they rose to 48,372 tons. The supply from North America, which, in 1856, was little more than 4,000 tons, rose in 1861 and 1862 to 7,500 tons; but in 1865 it fell to 5,300 tons. California, a new source of supply, sent last year (1865) 4,500 tons, and there were imports of copper from the Cape of Good Hope, though these, at present, are small; it is satisfactory to learn that there is a prospect of its ultimately helping the supply. Australia contributes its quota from the celebrated Burra Burra Mine to the extent of between 5,000 and 6,000 tons. Occasionally, small parcels are received from Russia and Siberia. From these countries, however, not much is to be expected, as the developing industry of Russia will absorb its production of copper. What effect the new commercial relations with Japan may have on the supply it is difficult to determine at present, but it is known that large and abundant mines of copper of excellent quality exist in that country.

The fluctuations in the price of copper are by no means a subject which may be overlooked on the present occasion, and there are reasons for supposing that on all occasions of advances these are not justifiable on the ground of deficient supplies; of this the recent operations in the copper trade, consequent on the declaration of war between Spain and Chili, are an example. From the 17th October, 1865, to the 15th November, copper was advanced £30 per ton, or from £86 per ton to £116; but in the face of the declaration of war, singular to relate, it has fallen, by one reduction of £10 and four reductions of £5, down to the original price from which it started, or to £86; the why and because is unveiled. It was *not* the demand for copper on the part of consumers, but the speculative spirit which induced the advance, the fall was a consequence of consumers holding good stocks of the metal, which, by their caution and foresight, they had purchased at a low rate; the bane and antidote is therefore before us. There are three separate elements in the copper trade—the miner, the smelter, and the broker or metal dealer; these do not on all occasions work harmoniously together. A fourth element will be recognised in the speculator, who frequently over-speculates. The smelter must sell, and therefore not unfrequently becomes the opponent of the speculator. To these causes, more frequently than the supply in the copper market, are the varying prices of copper to be attributed. In order to show the rise and fall of that metal, a table is appended, extending over a number of years, which embraces the average prices at which it has been sold from 1800 to 1865. Were it possible to compare the produce or supply in the market with the prices at which copper has been sold, a confirmation of the effect of speculation would undoubtedly be arrived at.

AVERAGE PRICES OF TOUGH CAKE COPPER PER TON IN EACH YEAR FROM 1800 TO 1865.

	£	s.	d.		£	s.	d.		£	s.	d.
1800	133	3	6	1829	109	14	0	1851	83	18	4
1801	117	8	0	1830	114	4	0	1852	95	0	0
1802	110	18	0	1834 }	106	11	0	1853	115	10	0
1804	136	5	0	1835 }				1854	126	0	0
1806	138	5	0	1840	93	0	0	1855	126	0	0
1808	100	7	0	1841	96	10	0	1856	119	0	0
1810	132	5	0	1842	88	11	0	1857	124	0	0
1812	111	0	0	1843	80	15	0	1858	108	0	0
1814	130	12	0	1844	83	2	11	1859	108	0	0
1816	98	13	0	1845	86	1	8	1860	105	0	0
1818	134	15	0	1846	90	10	0	1861	99	0	0
1820	113	15	0	1847	95	0	0	1862	97	0	0
1822	104	0	0	1848	84	18	0	1863	94	0	0
1824	110	0	0	1849	81	14	2	1864	101	0	0
1826	123	3	0	1850	84	2	11	1865	92	0	0
1828	112	7	0								

By reference to the above table it will be seen that the maximum of the price of copper was reached in 1806, when it realised £138 5*s.* per ton as an average throughout that year; in the months of March and April, 1853, it was nominally held at £145; of sixteen years, from 1840 to 1855 inclusive, the highest price reached was £135; and the lowest in 1843, when it was sold at £77 per ton. In the sixteen years beginning 1850 and terminating 1865, the highest average price was in the years 1854 and 1855, when it stood at £126; its lowest in 1851, at £83 18*s.* 4*d.* Copper, it is said, is £19 per ton below the average of the last sixteen years; but it is admitted that at £86 per ton smelters have a fair profit. Diminishing supplies are alleged, consequent on the Chilian war, the decreasing production of the mines of the United Kingdom, which has fallen from 24,257 tons in 1856 to 13,000 tons in 1865, and the Burra Burra Mine supply, from 7,500 in 1861 to 1862 to 5,300 tons in 1865. That mineral veins do work out is a fact known and patent to all metallurgists, as, for example, the Pary's Mine, in Anglesea, stated by a writer at the latter end of the 17th century to have a bed of ore forty feet thick, still worked; the Ecton Mine, in Staffordshire, is another illustration; it is not now worked; but as throughout all nature there reigns a law of compensation, if supply ceases in one direction it is compensated for by the discoveries of greater supplies in another, and thus the increasing copper trade of this country was provided for by supplies from Chili. The operation of the war there may for a short time interfere with these supplies, but there is no evidence that leads us to believe that the power of these mines to produce copper has at all diminished. Gold mining has alone drawn the labour from the Australian mines; we may look for supplies from Lake Superior; California gives evidence of its being a copper producing locality; the indications of copper from the Cape of Good Hope are cheering; and there is no reason to suppose that one-tenth part of the copper-producing localities in the world are yet known. That energy which has hitherto operated, and which is shown by the fact that, whereas the produce of the Cornish mines from 1726 to 1735 amounted only to 64,800 tons of ore, in the same period of time from 1846 to 1855, the quantity rose to 1,622,152 tons, the value of which was £9,251,916, while that of the former was only £473,000. The introduction of improved pumping machinery to drain the mines, consequent on the improvement of the steam engine by James Watt, an improved knowledge of metallurgy, the overcoming a prejudice on the part of miners against working for "yellows," abandoning the workings when these presented themselves, the re-working of imperfectly reduced copper "scoriæ" or "slag" all contributed to the result last named. We undervalue the bounty of nature, and the energy and intelligence of our metallurgists—the latter enlarged by the operation of the teachings of our Schools of Mines—in supposing that the supply of copper will diminish. Taper and Tadpole, in "Coningsby," wanted a good cry to go to the country with, in their celebrated electioneering crusade; the "speculators" in copper in the Chilian war got a "cry;" failing very singularly in that however, the new cry is, the probability of diminished supplies prospectively. The lesson taught them on the occasion named can be repeated. If speculators will speculate, let consumers keep up their stocks; it may be predicted that there is no reason to fear that the supply of copper will be diminished, even though the increasing consumption of copper is estimated annually at the rate of 8,000 tons. Three qualities of copper are sold, popularly known as Tile, Tough Cake, and Best Selected. The quotations given in the table refer to Tough Cake quality.

ZINC OR SPELTER.

The chief supply of zinc with which to mix the copper and produce brass, up to the year 1758, had been derived from the carbonate of zinc ore, or calamine, as it was called. In that year John Champion, of Bristol, patented the production of zinc, and the making brass from a stone called "Black Jack," or "brazill" and copper—"Black Jack" being a valuable ore of zinc, which, up to the period named, had been considered worthless, and had been thrown away or used for the purpose of road making or mending. This is probably one of the earliest instances of the recognition of the conversion of waste products, and should act as an incentive to the cultivation of applied science in connection with manufactures. It was matter of complaint among those at an early period interested in metallurgical pursuits in England, that our rich stores of zinc ores were sent out of this country as "ballast into foreign parts, in very great quantities, before it be wrought, so as the best brass beyond seas is made of our stone rather than their own, and the nation is aggrieved thereby," and thus Sir John Pettus, in his "Laws of Art and Nature in Knowing, Judging, Assaying, Fining, Refining, and Inlarging the Bodies of Confined Metals," published in 1683, expresses himself. The chief supplies of zinc appear, at an early period of the brass manufacture, to have been procured from Derbyshire, Flintshire, and Somersetshire ores. In 1796, the calamine raised in Derbyshire amounted to 1,500 tons, but it appears to have been of inferior quality, realising only 40*s*. per ton undressed, and dressed 120*s*. per ton; and was deemed inferior to that of Somersetshire, which realised from 65*s*. to 70*s*. undressed, and dressed 160*s*. per ton. Within the period of sixty years the quantity of zinc or calamine raised in Derbyshire had increased from 40 tons, in 1746, to 1,500, in 1796. If Bishop Watson was correct in his estimate of the Derbyshire returns in 1796, the quantity raised does not seem to have increased, as in 1859 the production was the same, *i.e.*, 1,500 tons. The returns of ores of zinc, given by the School of Mines in 1859, as being raised from English mines, amounted to 13,000 tons; Wales supplying about 5,500 tons; the Isle of Man, 2,500 tons; Cornwall, 2,400 tons; Derbyshire, 1,500 tons; and the remainder being made up by ores mined from Cumberland, Devonshire, and Ireland. The quantity of metallic zinc produced from the quantity of ore we have no account of; but, in 1864, the entire quantity of metallic zinc produced by all the mines in this country amounted only to 4,040 tons, while that consumed per annum in the making of brass in Birmingham alone exceeds 11,000 tons, from whence, then, comes the deficient 7,000 tons? The truth is, that we are indebted to foreign countries for our supplies; the Silesian and Vieille Montagne Companies and other foreign zinc smelters help us out of our difficulties. Incidentally, it may be remarked, that the metallic zinc used in England was chiefly imported; in 1731, it is said to have been sold at £260 per ton, £13 per cwt., or 2*s.* 4¼*d.* per lb.; also between the years named and 1780 at £74 and £48 per ton; in 1738, Champion, of Bristol, obtained a patent for producing metallic zinc from English ores; up to 1750 he had succeeded in producing 200 tons only; owing to foreign competition, it fell in price; he petitioned for an extension of his patent, "as up to the time named he had been a very great loser." In order to show the price at which metallic zinc has been sold for the last twenty-five years, the average price in each year, from 1840 to 1865, and from 1856 to 1865, is a very near approximate estimated value introduced in the absence of authorised returns:—

AVERAGE PRICES OF METALLIC ZINC PER TON IN EACH YEAR, FROM 1840 TO 1865.

1840 £ *s.* *d.* 34 8 4	1841 £ *s.* *d.* 41 13 4	1842 £ *s.* *d.* 46 6 8	1843 £ *s.* *d.* 35 5 10	1844 £ *s.* *d.* 30 5 0
1845 £ *s.* *d.* 30 16 8	1846 £ *s.* *d.* 29 0 0	1847 £ *s.* *d.* 27 10 0	1848 £ *s.* *d.* 22 9 2	1849 £ *s.* *d.* 21 10 10
1850 £ *s.* *d.* 20 19 2	1851 £ *s.* *d.* 20 18 4	1852 £ *s.* *d.* 21 6 8	1853 £ *s.* *d.* 29 8 4	1854 £ *s.* *d.* 30 7 6
1855 £ *s.* *d.* 29 12 6	*1856 £ *s.* *d.* *26 10 0	*1857 £ *s.* *d.* *33 10 0	*1858 £ *s.* *d.* *27 10 0	*1859 £ *s.* *d.* *23 10 0
*1860 £ *s.* *d.* *23 0 0	*1861 £ *s.* *d.* *22 0 0	*1862 £ *s.* *d.* *22 10 0	*1863 £ *s.* *d.* *21 0 0	*1864 £ *s.* *d.* *27 0 0
				*1865 £ *s.* *d.* *24 10 0

The highest price realised in the twenty-five years, from 1840 to 1865 inclusive, for zinc or spelter, was from November, 1841, to June, 1862, when it brought £49 per ton; and the lowest sales effected were in November, 1850, when it was sold at £19 10s.

Another means of supply of metal for use in the brass-foundry trade of Birmingham is in the return of old metal to be remelted. This consists of old sheathing, bolts and nails, worn-out locomotive and marine engine tubes, scrap metal collected in the country by hawkers; the filings, turnings, and dirt washings of casting shops, these several items from Birmingham brassfoundry establishments united together, with the old metal named, amount to not less than 8,000 tons. The largest establishments in Birmingham make their own brass; the smaller houses in the trade purchase the old metal revivified with new copper, cast in the form of ingots from metal dealers. Muntz's metal requires a large amount of copper to be added to it in order to bring it up to brass of ordinary quality. As, however, that kind of metal is usually taken back in exchange for new sheathing by the sheathing metal manufacturers, on payment, by the consumer, of a difference for reconverting it into new sheathing, it does not probably form an important supply to brassfounders generally. Locomotive tubes of Alston and Green's mixture contain a greater per centage of copper, approximating to the quality of best brass; they, therefore, are more available when remelted for brassfoundry purposes.

TIN OR BLOCK-TIN.

Though tin, as a metal, is comparatively little used, save in one department of the brassfoundry trade, viz., in bell founding, yet it enters into the composition of "gun metal," or the bronze of which Ordnance fittings are made. It forms a portion of the soft solder now but sparingly used (the less used the better) in "sweating" or attaching together certain parts of gas fittings, portions of stamped brassfoundry, &c., &c. It is occasionally used to mix with lead, to produce a harder metal, to make casting patterns from, when a small number of articles require to be cast, or where the patterns are large to save the value of brass which would be expended thereon. A passing allusion may be made as to the fact that tin appears to have been the means of establishing the earliest commercial relations between this and other countries; and that it was directly the means of producing our now advanced position as a nation, in science, art, and civilisation, may be gathered from the fact that 450 years before the Christian era, Herodotus describes the Tin islands of Britain under the name of the "Cassiterides;" this demonstrates that, as a market for tin, Cornwall was known long prior to the period when the historian wrote; and Diodorus Siculus tells how "the traders purchased the tin of the natives;" wild fellows they were, with painted bodies, fierce countenances, and shaggy hair. From these the traders from other countries purchased the metallic tin in huge blocks, transported it into Gaul, travelling through which on foot in about 30 days, they carried their purchases on horseback to the mouth of the Rhine, whence it was distributed into the countries of Italy and Germany. It is no stretch of imagination to conceive that in all probability the bronzes of Egypt, Assyria, and Greece owed their enduring properties to English tin, as most assuredly did those of Etruria and Rome; and the metallic mirrors or "pateræ," in which Herculaneum and Pompeian beauties surveyed their charms, owed their brilliant reflective properties to Cornwall tin, which also entered into the composition of the bronze of the numerous Statuettes, Lamps, and Ornaments, disinterred from the ash-covered cities in the vicinity of Mount Vesuvius, which form the chief attractions of the Naples Museum.

To the early purchasers of Tin from other countries, is due the introduction, or production of the composite metal Bronze into England, converted by the aborigines into weapons of warfare, objects of use, ornament, and personal decoration.

It is calculated that in the production of bells, soft solder, bronze and mill bearings, about 200 tons of metallic tin is consumed annually in the brass trade; this is entirely distinct from other quantities consumed in coffin furniture, Britannia metal, medals, and coining, which consume extra about 600 tons annually in this town. The price of Tin is subject to variations like copper and zinc. Between the years 1840 and 1856, both inclusive, the highest or average year was in 1854, when it sold at £121. 18s. 4d., but in the first three months of that year it sold as high as £130. Its lowest limit was in August and October, 1843, when it declined to £60 per ton, and the lowest average throughout the entire year was also in 1843, viz., £62 per ton. In addition to the supply of tin by the Cornish mines, occasional importations of tin ores are received from Bohemia, Saxony, and Malacca, and the richest deposits of the metal known are said to be in the province of Tenasserim, on the east side of the Gulf of Martaban, in the Malayan peninsula; Sumatra, Siberia, and Bolivia have also mines of tin.

The property of tin imparting to copper when mixed therewith various degress of rigidity, up to the extreme limits of brittleness, is one of the curiosities of metallurgy. That two metals, each soft and ductile when apart, united together in various proportions should produce bronze, rigid, yet tough, calculated to resist, for thousands of years, the ravages of time, atmosphere, and climate, and also be the means of transmitting down to our day the characteristic touches of ancient and mediæval artists; that a larger addition of tin should produce sonorous bells, hard and brittle; and that a further addition should increase the brittleness and add to the brilliant reflective properties of the alloy produced, forming in these latter days, the specula reflectors of the telescopes which Newton, Gregory, Herschel, Rosse, and Adams have directed to the firmament on high, penetrated the ethereal blue, and revealed the appearance of the surface of the sun and moon, and disclosed systems, planets, and stars until then unknown, is matter for wonder; and that two soft metals should produce a hard, is an anomaly curious alike to the initiated and to the tyro in metallurgical art.

THE OLD PROCESS OF BRASS MAKING.

As a new generation has arisen, when brass is not now made as formerly, the two methods of producing it will be here contrasted; the old method being first given, and the process is briefly described as follows:—The furnace used was dome-like in its interior, its bottom perforated with draft holes; round its inner circumference were ranged eight crucibles; in the centre stood a larger "king pot" or crucible; currents of air entered from below through the draft holes. The crucibles were made of fire clay; the charge consisted of calcined calamine ground fine, also of ground coal. These were mixed together, and thereafter levigated with water in the proportion of two gallons to 140lbs. of calamine and ground coal; 100lbs. of calamine and 40lbs. of ground coal, in a granulated state, were then passed through a sieve or riddle; this, in addition to 66lbs. of copper reduced to a state of bean or shot, completed the charge for the furnace named, and was distributed in the nine crucibles; the fuel, about 3cwt. of coal broken down to cubes about three inches square, was reduced by combustion to a coke state, the cinder or coke being carefully poked down between the pots, before the furnace was finally closed. To allow of the fusion of the copper, and interfusion of the calamine with it, ten or twelve hours were required to complete the melting of the charge. The "king pot" was first withdrawn, its contents stirred with a flat-ended poker; the contents of the surrounding pots were then emptied into the "king pot" and it was replaced in the furnace. After being exposed to the heat of the furnace again, it was, after being skimmed, withdrawn, and its contents emptied into ingot moulds formed of iron. If for sheet metal, these were long and flat; if the metal was for re-melting or casting from, they were of the usual ingot shape. Boulton states, as a proportion for making brass, in his letter to the Directors of the New Birmingham Brass and Spelter Company, that two tons of copper and three tons of prepared calamine should produce three tons of brass; and the brasshouse at Forest Works' calculation, quoted by Dr. Percy, shows that 9cwt. 1qr. 20lbs. of shot copper and 14cwt. 0qr. 16lbs. of calamine produced 14cwt. 0qr. 16lbs. of good brass, and an additional 10lbs. of "skimmings" or "settlings." The copper was estimated to increase 50 per cent. in weight. Watson says, at most of the English brass works 45lbs. of copper and 60lbs. of calamine obtains from 60 to 70lbs. of brass. The German makers obtained from 64lbs. of copper and 46lbs. of calamine and charcoal 90lbs. of brass, and the brass produced was equal in weight to the calamine used. In plain words, the metallic zinc was liberated from the calamine or zinc ore and united with the copper; the product was called Calamine Brass.

Another method of producing sheet brass of very great malleability was accomplished by placing alternate sheets of copper and layers of calamine, and in that position placing them in a suitably constructed muffle; exposure to heat volatised the calamine, which entered into the structure of the copper, and converted them into sheets of brass alike ductile and malleable.

Dr. Percy quotes an instance, in his work on Metallurgy, in which a large firm recently applied to an establishment in Glamorganshire for calamine brass, under the impression that it was superior to the brass produced by direct mixture of metallic copper, and metallic zinc; and, on authority, he gives the experience of a practical brass worker in Birmingham, who positively maintained that he could distinguish the difference between calamine brass, and the brass now made by direct mixture, in the peculiar appearance of its polished surface. If the former is superior, it appears a matter worthy of investigation what property has the calamine in its crude state, which is lost in distillation, or in its conversion into metallic zinc? We are accustomed to consider that all distilled products are the purest, and hence good copper and pure metallic zinc should produce, at least, equally good if not superior brass to the calamine brass of days gone by. If the latter is superior, surely the advanced metallurgical knowledge of to-day could settle the matter and tell us wherein its superiority consisted?

THE MODERN PROCESS OF BRASS MAKING.

The modern method of brassmaking, by the direct mixture of copper and metallic zinc, and by which brass is now produced, is practised as follows:—The furnace, built with fire-bricks, is ten or twelve inches square, and about twenty-four inches deep—the bottom is formed of iron bars—a space between each is left sufficient to admit of a draft of air. The fuel is coke—that produced in gas-house retorts, and called soft coke, is commonly used in Birmingham. The crucibles are formed of Stourbridge clay. An attempt has recently been made to introduce Plumbago crucibles, but, with the exception of one or two houses in the trade, they have not found favour. The furnace being lighted, the crucibles toasted, so as to deprive them of any moisture, are placed in the furnace, and then packed round with coke—the ingot or tile copper is introduced, when melted the zinc is cautiously dropped in, and its intermixture with the copper facilitated by means of stirring with an iron rod or poker. After remaining a limited period to facilitate the complete mixture of the two metals, the crucible is withdrawn, and its contents poured into ingots, or moulds of sand. It will be understood that, by a series of limited mixings, there may be differences in colour in the articles produced at the different "heats" or pourings, and this, in large houses, is remedied by mixing a considerable quantity of metal, pouring it into ingots, and storing it for future use; the re-melting improving the homogenity of the mixture or brass. It may be remarked, that should the metal be too long exposed to the heat of the furnace, the zinc flies off in the form of minute white flakes; the peculiar light which illumines the interior of a brass casting shop when the pouring operation is going on, is caused by the combustion of the zinc—this causes a loss in the weight of metal produced, and an allowance is therefore made to the casters for loss of metal of from 4lb. to 6lb. per cwt. In thin ornamental castings, where the metal requires to be poured hot, in order to fill all the intricacies of the moulds, the loss is greater than in heavy castings, when the metal does not require to be run into the moulds at so high a temperature.

Having entered into and discussed the early history of brass, the introduction of its manufacture into England, down to its localisation in Birmingham, noted the sources of supply of the raw material, and contrasted the Old and New processes of Brassmaking, the trade or manufacture as now conducted will be entered upon, and, as far as possible, the introduction of the improvements in manufacture, and the periods when these were introduced, with the rise and progress of the new separate divisions of the manufacture stated down to the present time. The earliest index or guide to the state of the brass trade is to be found in Pearson's Trade Directory of the year 1777; in which will be found only the general divisions, of Brass Founder, Bell and Cock Founder, and Brass Candlestick Maker. There is no doubt but the makers of all kinds of brass articles were designated Brass Founders, without regard to specialties. The divisions which now exist arose from the then manufacturers selecting some specialty which they considered they were most successful in producing, and which paid them best.

The increasing demand for brass articles, consequent on the advancing refinements of the period, the growing wants of society, and the practical application of scientific discovery—as in the introduction of lighting by gas—operated in extending old branches of the manufacture, and in originating new, until it reached the position it now holds as a special local industry with all its various ramifications. In some of the leading establishments of the present day General and Stamped Brassfoundry, the manufacture of Gas Fittings, Metal Rolling, Tube Making, and Wire Drawing are united; in others Cock Founding and the manufacture of Plumbers' Brassfoundry is practised. Cabinet Brass Founders are not unfrequently the manufacturers of General Brassfoundry. Stamped Brass Founders are Cornice Ring Makers, and unite also the production of Cornice Poles, all brass or partially covered. Metal manufacturers, in addition to the production of Sheet Brass, are not unfrequently Tube makers, and produce Brass and Copper Wire. Manufacturers of Yellow Metal Sheathing are producers of Ships' Bolts, Nails, and Brass Wire. Lamp makers of the past half century were also makers of Small Bronzes, or rather Bronzed articles; the original Lamp Manufacturers have been absorbed into or are now engaged in the manufacture of Gas Fittings. The divisions of the brass trade will, however, be most satisfactorily dealt with as follows, under the heads of—

1. Brass Casters.
2. Cabinet, Bell, and General Brassfoundry.
3. Cock Making and Plumbers' Brassfoundry.
4. Stamped Brassfoundry, Finished and in the Rough.
5. Rolled Brass, Wire, and Sheathing.
6. Tube Making.
7. Lamp Making.
8. Gas Fittings.
9. Naval Brassfoundry.

Two processes involved in, and common to the majority of the departments of the finished brassfoundry manufacture require description, before entering on the consideration of the specialties of each division.

The first, that of Designing, Modelling, and Pattern making; the second, that of Casting; the former necessitating a knowledge of ornament, the power of representing in relief in plastic material the design produced on the paper by the designer, down to the reproduction of certain definite forms of portions of the design of a plain character, as round or square and other shapes, forming connections, the patterns for which can be produced by the lathe, or by means of files or other tools.

The process of Casting involves, on the contrary, no artistic skill, but simply care in ordinary works, and ingenuity in the production of the moulds for what are called "cored" castings, *i.e.*, relief and shadow is produced by undercuttings, as in figures, &c.; with these exceptions, casting is a simple mechanical operation.

The *modus operandi* in each is as follows:—

DESIGNING, MODELLING, AND PATTERN MAKING.

At the foundation of the production of all works of an ornamental kind in brass, lies the design, which should be pure in whatever style, fit for the purpose intended as regards use, and good in construction. In plain words, the ornamentation should grow out of the construction. Weight of metal is an important consideration in the cost of articles to be produced in great numbers, as in the staple brassfoundry of Birmingham. Where no work of an ornamental kind is introduced on an article, the lathe, vice, and rasp, or file, will in general suffice to accomplish a first model, from which the crude pattern is produced. A cast is taken from the crude pattern, which is carefully turned or filed up, and a permanent pattern is made therefrom, which serves to produce thousands of casts. In patterns of an ornamental kind, the work is necessarily more complicated and difficult; it involves the taste of the Designer, the skill of the Modeller, and the careful and intelligent labour of the Repairer and Chaser. The designer having been put in possession of a knowledge of the article required, its style, dimensions, and the purposes it is destined to serve, proceeds to draw the design on paper of the work intended; if satisfactory, the structural parts of the work are made up, or should be, after which the modeller proceeds to model the ornamental parts, and this he does in plastic material, as wax, or pipe clay. French modellers prefer the latter material, as being more freely and expeditiously worked; the wax, or clay is worked upon with boxwood tools of various forms, and the details of leaves, flowers, and figures are produced thereby. From the wax, or clay model, a cast is taken in either lead or brass—which the "repairer" trims up or corrects—it is then passed into the hands of the "riffler," who carefully goes over all the surface with his small variously-shaped and bent riffles or files; all corrections being made, the chaser imparts texture with his chasing tools, as mattings, the veins of leaves, the centres of flowers, the hair on figures, where introduced, and the other details. All patterns of this kind are made of brass, the metal being hard is better suited to preserve the minute details already named. Such patterns are exceedingly valuable, and the stock of these of an ornamental kind in the pattern rooms of the leading manufactories in the lamp, gas fitting, and ornamental brassfoundry trade, in many instances, in value, may be estimated at from £1,000 to £5,000, the amounts named imperfectly and inadequately represent their value. The cost of a set of patterns for an ordinary wrought, or cast gas pendant or chandelier will reach not less than from £15 to £25, others, more expensive, to £50, and even more. Other patterns cost less, or more, in proportion to the greater or less amount of work introduced. In the production of such patterns, there is a considerable amount of risk, as some objects in the best taste in design are rejected for others more flashy and attractive. It is, however, satisfactory to record that there is evidence of the growth of a refined taste among English purchasers, and that such articles as show purity of design are more certain of sale now than they were some fifteen or twenty years ago. Designers and modellers realise various salaries or wages, from £2 to £5 per week, and higher according to ability.

A class of artists now exists, unconnected with establishments, who design and model for brassfounders, &c., who do not keep designers or modellers on their premises; the class alluded to receive the instructions of the manufacturer, make the design, and supply the models at a fixed sum. Chasers and repairers realise from 30*s*. to 50*s*. per week. Pattern makers, who prepare the patterns for the caster, and make plain patterns of the connecting portions, produced in the lathe, or by means of file and vice, are well paid—their wages vary from 30*s*. to 60*s*. per week. Good pattern making lies at the root of the successful manufacturing of Brassfoundry of whatever kind.

Following the natural order of the production of articles in brass, the process of Casting will now be briefly described, and the special processes which distinguish the several departments of the trade will be described under their respective sections or divisions.

PROCESS OF CASTING, BRASS CASTERS, AND CASTERS FOR HIRE.

In the various manufactures of the brass trade, after the preparation of the patterns, the most important is that of the caster. Of Brass Casters and Casters for Hire, who may be called Brass Castings Manufacturers, there are not fewer than forty-two in the town (totally independent of manufacturers or manufactories of finished brassfoundry), who practise casting as a separate department of the brass trade. They either supply the castings at so much per hundredweight, if the metal is supplied, or the castings at so much extra, including the price of the metal. The patterns are supplied by the smaller brassfounders, who do not keep casters and who require the castings. The price for casting varies per hundredweight according to the character of the patterns. 1st, from ordinary patterns, which can be readily cast, are easily removed from the sand, and are distinguished by the title of Common Castings; 2nd, from patterns which are called wrought, *i.e,* of an ornamental character, as foliage and scroll work, the mould faced on one side only, the metal of superior quality, the sand impressions or moulds from which are "faced" or dusted with charcoal powder (wood charcoal), in order to secure detail, and are distinguished as Single-faced Common Fine Castings; 3rd, to castings of a similar kind, but with work on both sides, which requires both halves of the mould to be faced; and 4th, Cored castings, the patterns of which are so undercut as to require a number of what are called "false cores," or pieces of sand built up or made to be easily removed from the mould, in order to get out the pattern, which cores are replaceable thereafter in the mould. This kind of moulding involves skill on the part of the moulder, and its complicated character will be best understood by the examination of an uncleansed cast of a plaster figure where all the markings show the several pieces of the mould not scraped off, and would indicate what are "false cores" in a brass casting.

The operation of Casting and Moulding may be briefly described as follows. The appliances are, a sand trough, free, good, and fine sand, cast iron or wood moulding frames or boxes, fitted together in two parts, moulding boards, clamps to hold the boxes together when closed, furnaces, Stourbridge clay or plumbago crucibles, and ovens to dry cores. The process of moulding consists in filling the first half of the box with sand; when filled, the patterns, if flat, are simply laid on the surface; if circular, they are driven in to half their diameter; dry parting sand is dusted all over the surface of the first half of the box; this is in order to separate the two halves of the box more readily; the upper half of the box is then dropt on, and is held there by dowels. The sand is then filled in and beaten down; a moulding board is placed on the back, the box separated (which is easily done owing to the parting sand); the patterns lifted out, "gets," or connections are formed, by cutting away the sand and connecting these with the appertures of the box provided for the introduction of the metal. The mould is then dusted over with "bean" flour, dried when necessary, the two parts or halves of the box closed together, and held in that position by clamps; the melted metal is poured in, and a perfect copy of the original pattern or model is produced. In fine casting, the mould is dusted over with "loam" or fine sand, thereafter with wood charcoal powder; it is then placed over the pattern again and beaten; the fine sand and charcoal powder copies sharply all the detail of chasing and minute markings in the pattern. Cored casting is a more complicated operation, as it will be readily understood that where draperies with their folds and undercuttings are introduced, on the attempted removal of the pattern or model, the portions of sand which fill these would be torn away; this must be dealt with and prevented. In order to avoid the breaking away of the sand, the moulder has to form small pieces of sand into portions or cores, which he can remove; a great number of "false cores" have to be made in some castings. These, as has already been stated, require to be so formed that they can be removed before the model is withdrawn, and require to be replaced before closing the mould or box. As the looseness of any one of these "cores" would spoil the casting, the cores require great skill in formation and placing. Moulding from an ordinary process is in this kind of moulding elevated into the confines of art, and is consequently an expensive operation; thus, while common castings, metal included, at present can be purchased at 11*d.* per lb., single and double-faced castings 1*s.* 3*d.* to 1*s.* 4*d.* per lb., cored castings cannot be had for less than from 2*s.* 6*d.* to 3*s.* per lb., and then not of the most complicated character; but the extra cost of "core" castings is more than compensated for by the shadows produced from the undercuttings, and the artistic character in consequence imparted to the work, if the model has been artistically executed. The metal used for articles of common brassfoundry is of an inferior kind, made from various kinds of scrap brass collected, re-melted, and poured into ingots. A higher class of metal for better class articles is made from copper, two parts; zinc, one part. The best work is produced from a mixture of three parts copper and one of zinc. The rich red metal of which best gas fittings and other works of an ornamental character have been made recently, contains a greater proportion of copper of "best selected" quality in proportion to the zinc. A very small proportion of lead improves brass for working by turning or filing.

Immense quantities of a species of money, known as "Manillas," were at one time produced in Birmingham by casting. It closely resembled an object figured in Knight's Pictorial England (a species of ring money), and was exported to the Spanish settlements on the New and Old Calabar, and the Bonny Rivers in Africa. In addition to that produced in this town, it was largely manufactured by the Bristol house of Harfords, and by the Cheadle Company, and was cast of a metal composed of copper, with a very large proportion of lead as an alloy, and hardened by arsenic. In an evil hour, however, a very sharp trader, not a little unscrupulous, animated by the desire to get speedily rich, conceived the brilliant idea of producing these objects in cast iron, and coppering them over by the electro deposit process. On their arrival at their destination the deception was at once detected, the "Manilla" rejected, and they now lie bulked up by the side of the African river where they were disembarked, are "taboo" to the Africans, and remain a standing monument, not to the honour and probity of the exporter by whom they were sent out. This gave the quietus to the manufacture of "Manilla" money in Birmingham until very recently, when the manufacture has been recommenced by Mr. Thomas Horne, in consequence of orders received for limited quantities. Once taken in, however, the "darkies" were not to be done a second time; with the order came the sable "mint master" of the tribe, who examined every example, rejecting those which were not satisfactory. No mean idea of the quick perception of these semi-savages will be gathered from the fact, that a few examples, slightly different in composition (which a Birmingham man would have passed over), and which, externally, formed no contrast to the bulk accepted, were at once thrown to one side, with an expressive "Ugh!" from the examiner. "Manillas," after being cast, were simply "shaken" in a revolving barrel, in order to remove the sand from the exterior, and to give an approximate degree of brightness, by a process generally adopted to brighten iron chain. Two other kinds of cast money were also made in the town, the destination of which was not clearly known; the one called "Cock Money," from the figure of a chanticleer being introduced on one side; the other a coin also with a square hole in the centre, and with Chinese characters surrounding it.

The specialties which distinguish the several divisions of the brassfoundry manufacture will now be discussed.

2.—CABINET, BELL, AND GENERAL BRASSFOUNDRY.

The manufactures of Cabinet, Bell, and general Brassfoundry, in the larger houses engaged in the production of brass work of the varieties named, are frequently produced unitedly in one establishment. Cabinet brassfoundry embraces the manufacture of all such articles in brass as are used by cabinet makers and carpenters in works executed by them. These articles may be indicated by the following condensed enumeration:—Castors, hinges, bolts, table fastenings, latches, handles of all kinds, door knobs and knockers, hat and coat hooks, pulleys of various kinds, blind mountings, blind racks, sash lifts, window fastenings, tassel and Venetian blind hooks, picture rings, sconces, lamp, gun, and other hooks, and an infinitude of articles in use for furniture and carpentry purposes made of brass.

In Bell Furniture Brassfoundry all appliances are included which are used in bell hangings, as levers, slides, quadrants, sunk, push, and other pulls, to give motion to the wires, and communicate with the bells; also common cranks, which drive into the wall with spikes, and others of a more expensive character on plates to suit internal and external angles; also mortise, pillar, wheel and chain, and spring purchase cranks. The latter varieties were more in fashion when the descending ribbon or rope was used, when the wires were seen, than now, when they are concealed in tubes inserted in the wall. The bell carriages to which the bells are fitted are made, and all the etceteras used in bell hanging, with the exception of the wire and tubes already named, which it is not the province of this department of the trade to produce.

General Brassfoundry may be said to embrace all articles in brass not included in the above, nor in the other departments of the trade to be hereafter treated of. The articles which may properly be enumerated as forming the staple articles of general brassfoundry, are railings of various kinds, as those for desks, balustrades for staircases, picture and hat rods, screen poles, banner arms, fireguards, window guards, window fittings for drapery purposes, and other articles of a special kind, made in small quantities, and for special purposes. The production of the latter class of work involves the employment of a better class of workmen.

As it is believed that the manufacture of articles of cabinet brassfoundry lay at the root of the brass trade in Birmingham, a glance will be taken at a few of the leading improvements therein. It may be affirmed that all articles produced at an early period of the introduction of the manufacture were much more substantial and heavier than they now are, and the patterns of a less ornamental character. Competition has reduced the prices, improved the external appearance, but, as a consequence, has rendered them, as a rule, less able to resist ordinary wear and tear. The tendency, however, is now towards articles of a better kind, if we except such as are supplied for the "slaughter" furniture trade of London. In lock furniture, shutter latches, and cupboard turns, the knobs of these were originally cast. They are now, and have been for upwards of forty years, raised from flat discs of sheet metal the conversion from a flat disc of metal being effected by means of raising tools worked in a press, which gradually renders the flat disc more convex, until it reaches the knob-like form. The partially formed knob is then placed in a tool in connection with the cast neck, round which a groove has been turned. The action of the press and tool compresses the metal of the partially formed knob into the groove of the cast neck, when it is complete and ready to be finished in the ordinary way. Recently, some excellent cast ornamental door knobs have been introduced of a very substantial kind since the taste for china and glass mortise furniture has sensibly declined.

The adaptation of China in connection with brass, to the purposes named, appears to have been introduced in 1844, by Harcourt Brothers; the china was procured from manufacturers of china and earthenware in the Potteries, and mounted by the brassfounders. This mounting suggested various ingenious methods for adapting and securing the knobs to the spindles, and regulating them to the thickness of doors—which, up to the period of the introduction of the china knobs, appears to have been but little thought of, or attended to. The application of china as Roses and Knobs to Bell Levers, followed as a consequence. It was then applied to form the terminal knobs or ornaments of Hat and Coat Hooks, and for various purposes for which it was, and was *not* fitted. So great appeared the demand for china fittings in connection with brass, that one firm in the cabinet brassfoundry trade (Messrs. Whitehouse) started the manufacture of china and earthenware in this town with special reference to articles of the class named; (in all probability the china bowl or wheeled castor, invented by J. B. Geithner, and popularly known as Cope and Collinson's, was suggested in consequence of the general use of china in brassfoundry). Glass, for the purposes named, *i.e.*, door fittings and bell fittings, never reached the demand of china and earthenware—this arose, in all probability, from its cost and difficulty in mounting it.

With the more general extension of the process of tube-drawing and solid stair rod making, the manufacture of coat and hat hooks, considerably changed from being cast, and are now chiefly made of tube, or their stems, if straight, were formed of iron, with brass cover, or of the same material as ordinary cased stair rods. When of bent or curved form, the tube is easily converted into the approved shape; and the ease with which tube, whether plain, twisted, or ornamental, can now be procured, gives the articles in connection with ornamental back-plates and knobs a very much more attractive character as regards appearance, while they may be said to be equally useful, always providing that the tube is not too light, and the solderings or attachment of the tube to the back-plate are good, while the price is proportionately lower than the former solid-cast articles—some of which, however, are still made, of a more ornamental kind, for the better class of buyers. One leading manufacturer, in his pattern book, has engraved 120 different patterns of hat and coat hooks. Within the last few years, a class of articles has been introduced, viz., portable wardrobe hooks or yokes, which have deservedly commanded a large sale; they are used, as the name indicates, for the suspension of dresses in wardrobes, or against the walls of dressing-rooms, &c.—the frames of these are chiefly made of tube, plain or ornamental; the arms which project when in use, are cast, and terminate with china or ornamental cast brass knobs. Very attractive long-grip door handles are also produced by the introduction of ornamental tube, associated with ornamental cast back-plates. Various ingenious mechanical arrangements have also been applied to blind mountings, for attachment to rollers of wood; but in point of cheapness, without reference to durability, the roller blind mounting of Loach and Clarke, made out of sheet metal, with iron pins to move in the brackets, rivetted in, commanded a very large sale; and the principle of the wedge, as applied to rack pulleys, introduced by the same manufacturers, was recognised on its introduction by an equally extensive demand.

In this article of rack pulleys, a considerable amount of small inventive skill has been expended. The moveable frame or carriage into which the pulley for the cord is fitted, has been worked in a variety of ways, in order to tighten the cord. It has been held by springs, moving down a straight ratchet or rack on each side; it has been attached to a strip of metal, and passed through a staple and held in its place by a thumb-screw; it has been mounted on a frame, which was raised and depressed by turning the knob or button attached to a screw, as it revolved, the carriage with the pulley being moved up and down the screw; the pulley has been worked by being attached to a rod, which worked in a cylinder, containing a spiral spring, and operated on the piston-like arrangement to which the pulley was attached, intended to keep the cord of the blind tense. While there were various methods of production tried, up to the year 1823 all were cast. In that year, Mr. Thomas Horne, sen., patented a method of making rack pulleys from sheet metal—on which the ratchet teeth were rolled in, or indented, in the process of rolling the metal. In this variety, the teeth were placed in the centre of the back, and one spring only was required to be attached to the back of the pulley carriage; then followed a host of rack pullies, produced by stamping, in 1844; the production of certain parts of rack pulleys, by means of the draw bench, being introduced by the Messrs. Harcourts.

A very clever application of ball and socket, to looking glass movements, was made by J. B. Geithner; it has the merit of working smoothly, and has quite taken the place of screw pins, which strip and refuse just when they are wanted to retain the glass at the desired angle; this arrangement has been applied extensively and successfully to other purposes.

The making of castors for furniture purposes absorbs a considerable amount of labour in the cabinet brassfoundry trade; formerly, these were of a more obtrusive character than they now are. In the old days of pillar and claw tables and curved out sofa legs, castors were prominent objects and decorations of the pieces of furniture in which they were introduced. As, however, fashions change in furniture as in other things, this form of castor has gone out, and even representations of them have been withdrawn from the pattern books of cabinet brassfounders, with one or two exceptions, as leading articles of manufacture. The sockets of the castors named projected out horizontally; ornamental examples of this form of castor represented lions' paws, Corinthian leafage, &c., &c.; in others, they simply bore the moulding, worked on the wood of the claw, and served as its termination; the horn and bowl worked below.

Of the ordinary round or now rarely asked for square socket castor, the former, particularly, are still made in large quantities. The present taste, however, in best furniture is to conceal the castors as much as possible, and hence a demand arose for Cabriollete castors, which are attached to the leg of the piece of furniture by means of a long screw; pivot and plate castors are also manufactured in large quantities. All the three varieties of castors last-named admit of concealment to a greater extent than the more securely fixed socket varieties. If there has been ingenuity practised in other departments of the Cabinet Brassfoundry trade, this specialty is no exception, and the various ingenious devices attempted in order to diminish friction and secure easy motion, have been numberless. The "pons asinorum" of the castor trade has been to invent a castor, the moving or bearing point of which is directly under the point of pressure. In order to secure this, spherical balls have been tried, to facilitate the easy moving of these spheres or balls, friction wheels and smaller balls have been introduced as cushions to help the action or movement of the larger sphere. All such arrangements have, however, resulted in the production of a "stand-still motion" only. In the limbo of unsuccessful patents, there are not a few having for their object ball or perpendicular castors. There would have been more failures, but the construction of the intended ball castor was changed within the six months allowed for specifying. In 1819, Mr. James Harcourt patented an improvement in the construction of castors, which consisted in a sunk chamber, divided from the superior part of the socket, by a diaphragm of brass; in this a flat disc with one small friction wheel was introduced, and, in addition, two small balls; the bottom of the horn was round turned true; when it was in its place it rotated on the balls and friction wheel. There were two claimants for the invention of the first conical pin castor, the one patented it, and the other, in defiance, made, and continued to make it. The improvement reduced the weight of the casting of the arms or horn in which the bowl rotates, and considerably diminished the friction of the horn on the pin attached to the socket. To Mr. Horne is due the introduction of the pivot principle. Mr. David Harcourt, in 1839, invented a castor on the same principle, but with a long pin and socket, which were introduced up the interior of the legs of the furniture on which the castors were fitted; the horn and bowl could be readily withdrawn from the socket named. Then followed Lewty's introduction of an external cast iron covering to the ordinary pin in the horn in which the bowl works; the covering was turned with the socket of the castor in the process of making. The pin head is formed with a round nut-shaped head, which served the purpose of the washer in castors of ordinary construction. On the horn and bowl being placed in the cast iron bearing, the pin is dropped down the centre of the cast iron covering till it projects considerably into the interior of the socket, and is held there by setting down; the extra length of the pin is inserted into the wood, on the exterior of which the socket of the castor is fitted, and improves the attachment to the leg. Castors with double or waggon wheels, had double sockets, the internal one of which was screwed to the leg, the outer one cast with the horn or arrangement for holding the wheel or bowl in one piece; the external socket moved freely on a pivot attached to the internal socket, and carried with it the horn and wheel. This arrangement was introduced by an engineer named McCalken, about the year 1839. No doubt there are, or may be other mechanical arrangements in castors which have escaped notice. As regards material, it remains to be stated that the wheels or bowls were at first made of discs of leather united together, on an internal bearing of brass drilled through to accommodate the iron pin on which the bowl rotated. Hard wood was also used, and brass bowls associated with brass sockets and horns were the rule, not the exception, until some fifteen years ago, when J. B. Geithner introduced earthenware as a material of which to form the bowls or wheels. These, associated with brass castors, commanded an almost unlimited sale, which will be largely increased, as the period of protection having lapsed, the monopoly is at an end. It remains to be stated that vulcanite has been tried as a material out of which to make bowls or wheels for castors, but abandoned as too expensive. It is more than probable that the new material "Parkesine," the invention of our townsman, Mr. Alexander Parkes, will eventually, no doubt, be pressed into the service of the castor for the same purpose.

In a decorative sense, the growing taste for metal-mounted decorated furniture, consisting of elaborate mouldings, ornamental handles, escutcheons, leafage, and terminations in metal associated with buhl and marqueterie in tables, cabinets, clocks, &c., will operate in raising the character and taste of the buhl cabinet brassfoundry. Some very excellent examples of this "Gouthière"* brass gilt mountings were executed for Messrs. Crace, of London, by Messrs. Cope and Collinson, and exhibited in the Paris Exhibition of 1855.

The demand for sconces of an attractive kind, consequent on the more general study of music (a result of the spread of taste and means of gratifying it), afforded by a reduction in price of musical instruments, as pianos, has largely operated in improving the bald, unattractive, clumsy appliances formerly in use for holding lights to be attached to the instruments named. The result has been recently some very attractive articles of the kind named, tasteful, neat, elegant and cheap. As regards hinges, they, as a matter of necessity, continue to be produced in immense numbers. Within the last few years, additional varieties have been manufactured of a more expensive character, but cheap in proportion to former examples; made in order to permit of the rising and self-shutting of the door to which these hinges are attached. The more general, almost universal, introduction of bells has considerably diminished the production of door knockers, though they still form an object of manufacture. As regards bell furniture, it is probable that in no sub-division of the cabinet and bellfounder's trade has any of the articles been so much improved as levers, pulls, and other internal metallic fittings, of a decorative kind in connection with bell hanging. An attempt is now made to approximate the style of these to the decoration of the rooms in which they are fixed, and at times with success; even without reference to special examples, ordinary stock articles of the kind are better and more tasteful. Call bells, which formerly were deficient in ornament, have also been improved; they have been placed on ornamental stands, and the pressure of a button releasing the hammer produces sound, while the bell remains in its stationary position on the table. Architecture has not been without its influence in connection with the spread of knowledge of the advantages arising to health by the free admission of pure air, and has resulted in a demand for bolts to close French casements, and also quadrants and stays, to regulate and retain the window open, in the desired position.

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* So called to preserve the name of the celebrated French maker of brass mountings for furniture.

The approximation of articles of brassfoundry, formerly of the baldest character imaginable, to those for a similar purpose of an ornamental kind, is a feature of the cabinet brassfoundry of the present day. But while the growth of taste requires ornament, the skill and sleight of modern housebreakers and "area sneaks," require to be met by ingenuity, invention, and substantiality. In this direction, various improvements have been introduced in window and other fastenings made by cabinet brassfounders, with the intention of preventing or rendering as difficult as possible the intention of such uninvited and unwelcome visitors.

As will readily be understood, with the two divisions of the brassfoundry trade already dealt with, General Brassfoundry, in its specialties, has kept pace. A greater desire to render shops attractive externally has largely increased the number of brass sash bars and name-plates made. The desire to display the goods for sale, attractively, has encouraged the production of handsome brackets to support glass shelves; and of perpendicular rods, with moveable projecting arms, on which to hang drapery articles, or to sustain trays, on which the jeweller displays the products of the goldsmith's labours; or they serve to support the results of the potter's lathe, or those of the Parian statuette artist. Engravings and oil paintings, water-colour drawings, or chromo-lithographs, now hang, not from nails driven into the wall, but are suspended from metal mouldings or picture rods, thereby greatly increasing the demand for these articles. Chains are now used to suspend pictures instead of cords, and an arrangement of strips of metal depending from the rod, and sockets with hooks attached moving in the strips, permits of elevating or lowering the picture, and altering its inclination to the light, or the reverse. This improvement was introduced by Mr. Thomas Pemberton. In public rooms, hat rods with supporting brackets have superseded the old coat and hat hook arrangement, and hollow stair mouldings, and ornamental tube rods of a massive and decorated character, have taken the place of the former solid iron rod, cased with brass of so meagre looking and poverty stricken an appearance. The introduction of the Penny Postage by Rowland Hill operated on this branch of trade materially—how it did so is strange, but true. Immediately on its coming into effect, came the demand for letter weighing machines, which were made in immense quantities, and letter box plates were introduced, made, and continue to be made, in very considerable numbers. The revived art of needlework, or embroidery, by which queens and ladies of the olden time wiled away the time in the absence of their lords, engaged in the sterner pursuits of war at home or abroad, has not been without its influence in the production of tasteful fire-screen banner stands, and banner arms to attach to mantelpieces, from which to suspend embroidered banners, worked by skilful and delicate fingers. The production of these has recently been very large. Even female fashion, on the introduction of irrepressible crinoline, aided the general brassfounder: for with crinoline came the necessity for protecting the steel-distended and expanded skirts, in which girl, maid, matron, and widow were, and still are attired, from the dangers arising from fire. The number of fire-guards of a superior class produced in consequence, on a moderate calculation, numbered upwards of 20,000. One manufacturer produced 4,500. These guards varied in price, from 15*s.* up to £3 each, and therefore formed no mean addition to the return of these manufacturers. The number given is independent of other and cheaper articles of the kind produced by wireworkers in iron and brass wire.

In the processes of manufacture in connection with Cabinet, Bell, and General brassfoundry, there has been little change, so far as regards manipulation, with the exception of the application of steam power to the turning of the lathes. One establishment only, that of Messrs. W. Tonks and Son, has used a machine invented and patented by Mr. Thomas Potts, but improved upon by them, for "floating" tube. The machine is automatic in its operation; the tube to be floated is attached to the horizontal bed; the floats, of which there are five, move parallel and longitudinally in their action; they each pass a little way into the space previously floated, but the juncture is perfect, and free from the peculiar indications, which marks the stroke of the "float" where it joins, when the tube is "floated" by hand labour. The tube operated upon is turned also by the machine, and exposes a new portion of surface to be operated upon, until it is floated in its entire length. It is singular to think that of the millions of feet of tube in a straight form, as picture, hat, stair, and other rods, with finished tube, "for cutting to length," and tube cornice poles sent out annually, that until within the last ten years it was floated, and still is, with the exception named, by manual labour only. That workmen exist who have spent their lives in an operation, which realises Monsieur Mantallini's idea of the "demd horrid grind," the genuflexions of a bowing dervish, or those of a "pit sawyer," is, in this age of invention and progress, matter for wonder and remark.

The curiosities and oddities of the manufactures form one of the topics to which the attention of the writers of these reports on Local Industries is directed. The examples which follow are, it is thought, worthy of record. While the bodies of the rulers of Egypt—the Pharoahs, Ptolemies, and Cheops—reposed in huge sarcophagi of stone or granite, and the great ones of Greece in those formed of marble, storied over with incidents in their lives cut by the sculptors of that period; and graceful urns, produced in the clay of the potter, accommodated the ashes of the dead Etruscan; in more recent times coffins of lead, oak, mahogany, and other woods have been used for our dead, down to elm or blackened deal, which forms the parish case, or box to contain the body of the "pauper whom nobody owns." Now modern invention has also given us coffins of glass, of iron, and of zinc, and even inserted in the last, plates of glass directly over the countenance, in order to enable friends to survey the ravages of the destroyer on the visage of the silent tenant; but none of the materials named were grand enough to form the mortuary chests destined to contain the remains of two palm oil potentates, who ruled, or rule, on the South Coast of Africa, and bore, or still bear, the euphonious titles of "King I Am," and "Egbo Jack." They desired their coffins to be made of brass; they were then alive, and wanted to see them before they were permanently used. Of brass the coffins were accordingly made; each coffin was 6ft. 10in. in length, 3ft. in depth, and 2ft. 3in. wide at the widest part. The whole was polished, lacquered, and richly decorated with cast ornaments, and had substantial handles. A shield with emblazonings surmounted the lid of each; but the most singular feature which marked these objects was the introduction of four padlocks in and on each, two of which were attached to the interior, and two to the exterior. The interior padlocks had their hasps, and could only be locked from the inside. Report stated that the coffins during life were intended to serve the purpose of an oratory, or private cell, into which the proprietor retired for devotional purposes, locking himself in during his spiritual exercises; each coffin weighed 600 pounds. A more prosaic reading of their use will be found, it is thought, in their owners using them as receptacles for their treasure during life, and after death to be buried in the coffin with it, as is the custom in that country of Gold Dust, Elephants' Tusks, Palm Oil, and Vegetable Gums.

It would have been satisfactory to have been able to have instituted a comparison as to the reduction in price of articles of Cabinet Brassfoundry and Bell Furniture made at a former period with the same class of articles produced now; this, however, is scarcely possible. While gross prices in the old suites of patterns remain the same, discounts have been changed, and new suites have been introduced or substituted, in some cases the articles are lighter, in others the same articles have been improved upon in external appearance.

In General Brassfoundry a like conclusion is arrived at: better and more attractive work is now produced, and sold at a comparatively moderate rate. The difference in cost now does not entirely consist in the weight of the article being diminished: division of labour, and competition, have united to produce the reduction in price.

In these united sections of the brassfoundry trade treated of it is assumed that at least one-third of the workmen employed in the brass trade are engaged. There exist two modes of payment of wages. Men who head shops and pay their assistants by the piece—such men realise from 35*s.* to 50*s.* per week at best work; good workmen, paid by the week, average from 25*s.* to 30*s.*; secondary workmen, according to ability, from 15*s.* to 25*s.* Juvenile labour can accomplish a good deal in the preparatory operations, and useful lads get from 7*s.* 6*d.* to 10*s.*; boys from 3*s.* 6*d.* to 7*s.* Female labour is but little taken advantage of in these departments, and is confined to lacquering and wrapping up only. Good lacquerers realise 10*s.* per week; inferior 8*s.*; and girls 3*s.* to 5*s.* per week; wrappers-up, 8*s.* to 10*s.*

3.—COCK FOUNDING, PLUMBERS', AND ENGINEERING BRASSFOUNDRY.

The manufacture of the first-named class of articles appears in the earliest directories, 1773, as a distinct and separate branch of the brassfoundry trade; but in the year 1780 we find six cock founders named, who appear to have specially directed their attention to the production of this universally useful form of metal work. In all probability the manufacture of taps is identified with the introduction of the brass trade into the town, and formed among the earliest examples of its productions in the metal named; though it must be admitted that the metal out of which these were produced, until recently, could scarce be called brass, its composition being as follows:—

	lbs.
Copper	6
Lead	7
Turnings or filings of cocks in process of finish	10
Old cocks	7
Tin	1
	31

This composition was designated "pot metal," a superior quality of which was used when the necessity for hot water cocks in order to supply the demand for kitchen boilers, and the modern luxury of baths were introduced. The metal of which these were made was composed of—

	lbs.
Copper	2
Lead	1
Tin	1
	4

The more general application of steam has not been without an influence in the cock trade, the immense pressure it exerts calling for a special metal to resist its pressure, the heat also is another element which calls for a change in the composition of metal, of which the cocks used for steam are made. On the same authority as has been already quoted, the metal of which steam cocks are at present made is composed of a "bronze" or "gun metal," consisting of—

	lbs.	oz.
Copper	14	0
Brass	4	0
Tin	0	14
	$18\frac{14}{16}$lbs.	

While, however, the old "pot metal" is occasionally used for low-priced articles for export purposes, cold liquids, &c., it is stated, though the quantity produced has not sensibly diminished, the demand for cocks of a superior quality of metal consequent on the introduction of water into towns, has proportionably increased; these are known in the trade as "yellow metal cocks," and are composed of—

	lbs.
Copper	28
Zinc	7
Lead	7
Tin	1
	43

The appearance of "pot metal" cocks when first cast is by no means attractive, in the common examples they exhibit a leaden coloured exterior, and if the metal has not been properly mixed, and a union of its component parts effected in the melting, globules of lead may be detected on the surface. The pattern making for the manufacture of cocks involves no small degree of skill and knowledge, and the making of the core boxes, by which the entire barrel of the cocks is cast hollow for the passage of the fluid, and for the plug, involves very great nicety of workmanship in order that the requisite thickness of metal may be preserved throughout. Into the core, supports of thin wire are introduced in order to strengthen the sand of which the "core" is made. The mould being made as in other kinds of brass casting, the core is laid in the spaces indicated by "prints" in the model, or casting pattern, and the space left between the core and impression of the pattern is taken possession of by the fluid metal, when the moulding box is closed and the metal is poured in. Several of the varieties of cocks, as regards form adapted for special purposes, are of a very complicated character, and the patterns for these and core boxes are correspondingly complicated. In their primitive form cocks were constructed on the simplest principle, viz., with a plug, which allowed the liquid to pass through an aperture in it when presented to the orifice of the barrel, the keys or plugs were held in by being rivetted, after fitting sufficiently tight to keep the plug in its place, and to permit of its being turned easily round by its cross head. It will at once be understood that by this arrangement any internal obstruction could not be removed which would interfere with the action of the tap; as grit, which cuts the plug, and renders the working imperfect, resulting in the escape of the liquid the tap was intended to conserve. It was therefore a very great improvement when the screw and washer took the place of the old rivetted mode of securing the plug, as the plug could be readily withdrawn for examination. The washers, from a simple perforated disc with square hole in the centre, assumed, in the hands of some manufacturers, that of a helical spring, the pressure of which was regulated by a screw also. Others mortising the bottom of the key introduced a "cotter" pin; the "cotter" also was increased in its action by a screw. Springs were also introduced in a variety of cocks designated "lock cocks," specially devised with the intention of preventing the surreptitious abstraction of the liquor. In this variety a key, which could be withdrawn, and which fitted on to a corresponding piece of metal projecting from or into an aperture, sank into the upper end of the plug. The plug was protected from being tampered with by being covered with a cup, the aperture on the top of which was cut into a form to permit of the introduction of the portable key with which the plug was turned, and egress of the liquor procured. In this variety the spring was introduced on the upper surface of the plug, and, consequently, pressed it down into the barrel. In some examples the taper of the plug was reversed, its thickest part being at the bottom of the barrel, and it was forced up into its seat by a thick screw, which fitted into an internal thread cut in the bottom of the barrel, the friction of the key plug being regulated by a thick plug screw.

A what was called "Syphon" construction was then introduced; this consisted in perforating the plug at right angles, so as to permit of the escape of the fluid from the bottom of the plug, the projecting curved end, from which the liquor is drawn in the common examples, by this arrangement being entirely dispensed with. In the cocks hitherto named, the material was entirely metal, the key or plug worked against metal, but an innovation took place; a cork chamber, ferrule, or lining, was introduced in the interior of the barrel, formed of metal externally, and in this cork ferrule the metal plug worked, the elastic nature of cork adapting itself to the unyielding nature of the metal of which the plug was composed. The other constructions of cocks refer chiefly to what may be called "screw down," and those in which the apertures are closed by valve-formed stoppers, operated upon by screws, to which motion is given by turning the cross-head of the external key, and thereby operating upon and pressing down the conical-formed piece of metal which stops the passage for the water. Diaphragm cocks are now also largely made in Birmingham, since the expiration of Lambert's patent, which may be said to have been the most successful and most universally adopted new construction over all others.* In that variety of cock the aperture is closed by vulcanised Indian rubber, operated upon by a screw which is attached to a diaphragm or elastic disc of rubber held round its upper and under outer circumference between brass flanges by four brass screws; on turning the external cross head, the screw brings up along with it the central portion of the rubber disc, elevating and raising it from its bearing, opening thereby the passage for the fluid, or in moving the screw by turning the key in the reverse direction the disc is pressed down, and the orifice closed to prevent the escape of the fluid, and stop the passage.

Any further attempt to describe the minute distinctions or difference in the construction of the articles treated of, without the aid of woodcuts, would simply confuse; suffice it to say, that in this as in other sections of the brass trades there have been numerous patents taken out involving a greater or less amount of mechanical ingenuity; withal, however, no great attempt has been made to change the mode of manufacture from "manual production" to that by which the same class of objects can be partially if not entirely produced by machinery. The "tighted" department of the trade, *i.e.*, that wherein metal "plugs" are fitted and tighted into metal "barrels." So far as regards the artisans engaged therein, the majority still support their special "trades union" as members of which they do not encourage the introduction of any new appliances to aid them in their labours; probably the increase of the "screwed down" element may induce them to listen to reason, and cause them to abandon a combination which depends for its very existence on the retention of the present crude methods of working. The baneful effect of unions has never been more forcibly shown than in that of the file makers of Sheffield. Ignoring the steadily improving character of file-cutting machinery they struck—the result has been rendered painfully apparent and costly to the workmen.*

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* The introduction of the cork barrel cock is attributable to Martineau and Rudder, and to the first named the patent globe cork, with half cork plug; also an improved shaped syphon cock. "The screw-down variety of cocks were introduced by Guest and Chrimes, of Rotherham, and the India rubber diaphragm cock by Lambert's, of London and Walsall."

One thing is certain, that the first manufacturer who takes advantage of ingeniously constructed machinery for the production of "tighted" taps, &c., as is now done in the manufacture of the component parts of gas fittings, before him must the union, or any combination fall. The total number of workmen engaged in the manufacture of "tighted" taps, or cocks, may be estimated as reaching nearly 300; of these 160 may be calculated as belonging to the union.

It is not possible to estimate correctly the number employed in the "screwed down" manufacture.

The designations of the various kinds of cocks made are as follow:—Patent Globe, Syphon, Range, Bottling, Racking, Beer machine, Wine, Spirit, Bib, Ball Valve, and Cannon ended; large examples for distillery boilers, and other purposes. To these, chiefly used for the purposes named, may now be added, produced in gun metal, for Engineering purposes Lubricating Cups for machinery, Grease Cups and Taps, Steam stop cocks, Steam whistles, and Steam gauges, to be attached to boilers. The manufacture of these has been added to the trade of the manufacturers of cocks within a few years, and is consequent on the large increase in demand for machinery, hot water and steam heating apparatus, and a growing recognition of the importance of the division of labour, the engineers finding out that it is more economical to buy such taps, &c., than manufacture them by their own workmen, the very change of tools for one object to be produced materially adding to its cost; and practice in the making of taps enables even the tap workmen of Birmingham, with their simple and crude tools, to make the articles at a cheaper rate than they can be made by engineers on their own premises. Cock making is a good illustration of cheapening consequent on the division of labour, or rather expedition arrived at by confining the manipulation to one particular object or class of objects. The production of taps, or valves, to resist the force of steam successfully necessitates superior and skilful workmanship—the bearings of the plug perfect throughout the entire length of barrel. In a tap exposed only to the weight of a fluid, as the water, beer, &c., in a cask, the plug may only be a comparative fit, and, well doctored with tallow or wax, may not at first show its defects; try the same tap on a water pipe, with the ordinary pressure used in water works, or place it on a steam pipe, its defects are rendered apparent in an instant, and the difference between good and bad work is speedily revealed. In the same manner steam valves require to be well seated, and every portion of the two surfaces of the valve and seat should be in the closest possible contact. The certainty and ease with which a valve cock can be closed, and the valve held *in situ*, has within the last few years increased the demand for this form of cock.

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* The Sheffield correspondent of the *Leeds Mercury* says:—The result is an unconditional surrender on the part of the men. The pecuniary loss in the struggle has been immense. The unions have incurred a vast amount of debt, and it is calculated that there has been a loss of £70,000 or £80,000 in wages alone. The masters have suffered heavily, and several of the weaker firms have got into the *Gazette*; but the triumph of the masters, as a body, has been complete. It should be added that machines have already been erected, and with their aid the masters hope to be able to retain the pre-eminence that Sheffield has hitherto enjoyed in the file trade.—*Daily Post*, June 19th, 1866.

The intention, in alluding to the particulars last introduced, is to show that the importance of really good work involves good and expert workmen, who are paid much better wages than those of the same class are in other departments of the brassfoundry trade.

An intelligent manufacturer in the cock-founding trade states the wages of workmen who make best articles as from 42*s*. to 45*s*. per week, after paying his assistants and helps. It is probable that in no department of the brass trade has there been less change in tools and appliances for working than in that which attention has now been directed to. The old process of boring-out is retained, the square steel borer and wood splint operated upon by a "dwang," the borer pressed down by a perpendicular pressure screw; even the oldest form of lathe known—that of the pole lathe, is still used in cock barrel finishing. As, though very old, its very existence may be new to our readers, a description of it is introduced:—It consists of a pretty stiff, springy ash pole, six or seven feet in length; one end of it is fastened to the ceiling or beam; the other end is left free; to the free end is attached a gut band; a maundril, or arbour of wood, works on two centres, between wooden supports. Round the end of the arbour the band is wound, and its extremity is connected with the treddle. The cock barrel to be part turned is passed on to the arbour; the workman applies his foot to the treddle, and, by long practice, gives the arbour such an amount of revolution as exposes just so much of the barrel of the cock as requires to be turned to the action of the tool; in this manner all the barrel is turned that can be; the remainder is finished by filing. The "jiggle," "jiggle" action of the machine is ludicrous, and suggests, could not modern machine making ingenuity invent a substitute? be this, however, as it may, the production of cocks of common forms or kinds, will ultimately be by Machinery.

Why the manufacture of Cocks and Bells should be allied together, and produced in the same establishment appears difficult to explain, as does also the union of Bells and Candlesticks. In all probability, however, the production of bells filled up the spare time of the caster engaged. The connection between Cockfounding and Plumbers' Brassfoundry seems more natural, and as such readily accounts for the manufacture of the last-named in connection with the former.

Plumbers' brassfoundry includes among its productions the manufacture of the smaller kinds of Hydraulic Machines, as Lifting and Forcing Pumps, Garden Engines, Beer Engines, Fire Engine Couplings, Washers and Wastes, Washers and Plugs for Washhand Basins, Valves of various kinds for Cisterns, and other purposes, as Baths &c., &c.

The more general recognition of Sanitary principles, their adoption and incorporation in the legislative enactments connected with the health of towns, have materially operated in increasing the united trade of the cock and plumbers' brassfounder, and given it an impetus and an importance commensurate with the benefits resulting from the introduction of measures calculated to improve the health of communities where plentiful supplies of pure water and a comparatively perfect system of drainage have been introduced, and have taken the place of vicarious or limited supplies and imperfect systems of drainage, equivalent to no system at all.

4.—STAMPED BRASSFOUNDRY, FINISHED AND IN THE ROUGH, PIERCING, CORNICE POLE, AND RING MAKING, ETC.

The writer was led to identify the introduction of this division of the brass trade with the period of the introduction of the manufacture of coffin furniture into Birmingham; on investigation he finds his conjectures confirmed. The germ of the stamped brassfoundry is not due to local talent, but is the invention of John Pickering, of London, a jeweller, or gilt toy maker, who, on March 7th, 1769, patented "a new method of performing that kind of work called chasing, for gold, silver, brass, tin, and other metals, but more especially to be used in the production of coffin furniture; also ornaments for coaches, chariots, cabinet brass work, and domestic furniture." The stamp is described as with two upright rods, a falling hammer to which "the force" is attached, the position which the "die" occupies on the bed of the stamp, and how it is held; and the inventor winds up his description by modestly saying "that thereby work is executed in a much more expeditious manner, and far superior in beauty and elegance to anything of the kind (not being actual chasing) ever yet performed by any other method." A few months thereafter, on August 7, 1769, we find a Richard Ford, of Birmingham, adopting stamping as a means of raising scales, sauce, and warming-pans, basins, and kettles. In 1777 the invention of the London jeweller or toy maker had evidently reached Birmingham, and some clever patent agent of the day drew a patent for John Marston, a brassfounder, and Samuel Bellamy, a die sinker, both of Birmingham, patenting the stamping *(not of brass)* but of rolled gilt and plated metals, into hat and cloak pins, all kinds of figures, decorations, ornaments, and other devices for cabinet and lock furniture, with the introduction of colours into the same. The colours were introduced behind perforations. Metallic foils were occasionally used, *i.e.*, such as are still employed by jewellers to place behind the settings of stones to enhance and give depth to their brilliancy and colour. The lacquer used is stated to have been made from gum sandrach dissolved in spirits of wine. Articles not plated or gilt might be left of the natural colour of the metal, and lacquered with a varnish composed of seed lac dissolved in spirits of wine coloured with annatto. The initiated will have no difficulty in recognising in the patents of Pickering, Ford, Marston, and Bellamy the germ of the present Stamped Brassfoundry trade, as it now exists and is practised.

For the information of nonpractical readers, it will be proper to state that stamped brassfoundry differs from cast, in so far that its raw material is sheet brass, produced by rolling cast ingots or strips of Brass into thin sheets in the manner hereafter to be described under the head of metal rolling, &c.

That the introduction of Stamped Brassfoundry was regarded as something very important may be gathered by reference to a work published in Birmingham, in the year 1780. It is amusing in these days, when every newspaper has its critic of art and manufactures, to observe the laudatory strain in which the then writer announces the introduction of the new process in the Brassfoundry Trade. After alluding to the prejudice which existed in favour of "town made articles," *i.e.*, London made—he says, "though artists of unrivalled excellence exist in London, every Londoner is not an artist, and they did not carry everything to the perfection of which it was capable," a striking example of which will be found by the comparison he makes as to the superiority of the stamped brasswork produced in Birmingham. These consisted, even at that early period, of mouldings for rooms, furniture ornaments, girandoles, picture and looking glass frames, and he proceeds to say that "the old process of casting is utterly laid aside and a more cheap and expeditious method is substituted. Artists of inventive minds and unwearied application have called in the aid of dies, presses, and stamps, and one man can, in the same space of time, produce what, on the old principle, would have required ten to perform, and by this improvement beauty and elegance may be obtained without incurring the enormous expense which has hitherto accompanied them."

Two firms appear to have monopolised the stamped brassfoundry demand of the period, 1783, viz., Jones and Barker, and Gee and Eginton, who represent themselves as manufacturers "of coffin furniture, in best white metal, silvered on Britannia metal; looking glasses and pictures in gilt metal, or burnished gold frames, bordering, and ornaments for rooms, in stamped paper or gilt metal." The firm who more particularly achieved success in this department of the brass trade was that known as Yates, Hamper, and Co., now extinct. The writer of this paper had in his possession, until recently, a curious pattern book of the house named. The designs, though of the semi-classic period then fashionable, indicated aspiration after a better style of ornament. He has also recently examined examples of the works themselves; though dimmed in lustre after the lapse of sixty-five years' exposure to the atmosphere, the impression of the die (though the dies were shallow) was sharp and well brought up, and the finish, where the lacquer was not removed, would amply justify the opinion of the critic alluded to, *i.e.*, "that many of the articles, particularly the picture frames, were so richly gilt that they pass with very good judges for burnished gold."

Increased familiarity arising from the practice of the stamping process led to bolder attempts to produce ornament in greater relief. The dies from which the articles were stamped were sunk deeper, as experience was gained that by annealing the ductility of the metal was restored. Many articles then made in stamped metal are now but seldom asked for, and have almost ceased to be represented in the pattern books of stamped brassfounders, as for example, Curtain, Hat, Cloak, and Looking-glass Pins, Bed Caps, Drawer Knobs, Handles, the shields of which were stamped and represented lion heads, &c., &c., grasping rings of tube; lion and bird claws, grasping balls of sheet metal, used as feet for tea caddies and workboxes; Key-Hole Escutcheons, Bell Pulls, with stamped ornament to attach to the ribbons, used to ring bells, before levers were introduced, and upholstery decorations of a now obsolete kind; but while the articles named have fallen before change of fashion, they have been more than compensated for by an immense demand for articles in another direction for uses in trade undreamt of by early manufacturers of stamped brassfoundry. Finger plates, at first cast some 40 years ago, began to be stamped; they then realised 30*s.* per dozen. The first stamped finger plate was made by Mr. Thomas Horne. A similar article is now sold at 12*s.* per dozen. Cornice pole ends, originally carved in wood and gilt, began to be made of cast brass; eventually they were and are now stamped, the pattern selected for the first experiment being a cast brass example of the knob or projecting-out kind, made by Messrs. Abercombie, brassfounders, of Soho Street, London. The first departure from the form named is due also to Mr. Thomas Horne, who designed and introduced an end which returned, and displayed a rosette, blossom, or flower in front. To the same manufacturer is due the introduction of the drop or pendant end, brought out in 1844, which may be said to have been the great hit in the cornice end manufacture. "The Fuchsia," on its earliest introduction, from its novelty, attracted attention, and the demand for it for some time almost exceeded the means of supply. The inventor, however, had had the good fortune to register his design; the result was other manufacturers who had slightly altered the design and gone into the market as competitors were compelled to acknowledge their obligations by payment of a royalty. 16,000 pairs of this Cornice end were made by the inventor during the five years his registration lasted; since then, at least double the number have been made. The idea once suggested of a pendant end, it has been the progenitor of a host of Grape, Plumb, Apple, Filbert, Rose, Chesnut, and other ends, which hang from the ends of cornice poles and form their terminations.

Glass in the form of blossoms, fruit, leaves, &c., associated with stamped brassfoundry, and introduced by the writer of this in the year 1846, marks another era in the stamped brass-Foundry Trade. As in the case already alluded to, the demand at first for cornice ends and curtain bands of the Lily and Fuchsia pattern, (the lily and fuchsia flowers being of opal or other coloured glass, the leaves of metal,) was with difficulty supplied. In the space of 14 years, to which the patent extended, the sale reached upwards of 90,000 pairs.

Change of fashion obliterated the old method of sustaining the drapery window curtains, by means of what were called Curtain Pins, and Curtain Bands took their place; these, on their first introduction, were made of sheet metal about ⅛ of an inch thick by 2½ or 3 inches wide, or were cast; if of sheet metal, they were ornamented by "milling" or "cording" tools, *i.e.*, small circular tools, which revolve on a pin, the external diameter of which tool or roller bore an impression or design. The tool, when held or pressed against the revolving metal in the lathe, communicated to the metal the counterpart impression. The metal was soldered on to a hoop and turned on a chuck in the lathe, the milling tool applied and held against the hoop until the desired impression was produced, the hoop was then sawn open, the milled strip bent into form, and thereafter dipped, burnished, and lacquered, &c. This, of course, was too good an opportunity to be lost. An article to serve the same purpose was produced by stamping, very much lighter and cheaper, which, in the end, drove the cast heavy sheet metal varieties out of the field. The sale of these articles (curtain bands) still continues, though now somewhat limited by recent changes in taste, and the substitution of cords and tassels. Novelty rather than good taste would seem to have presided over the design of the ornamentation of many of these curtain bands. While some of the designs have been chaste and elegant, the majority have bee just the reverse; as for example—(and novelty would seem to have operated in no small degree some years ago)—during the agitation of the movement for the purchase of Shakespere's House, at Stratford-on-Avon, a manufacturer introduced curtain bands and cornice ends *en suite*, the ends a swan, *i.e.*, that of Avon, from the beak of which dangled a portrait of Shakespere in stamped brass; the curtain band had a medallion portrait of the dramatist introduced, surmounted by the bird already named. The rage for "polking" also resulted in a Polka Curtain Band.

Some thirty or thirty-five years ago, Window Cornices, till then formed of wood carved and then gilt, or of wood structurally, and compo ornament superficially, also gilt, begun to be made of thin stamped sheet brass, were effective, and possessed the advantage of being readily restored by cleansing and relacquering at a much cheaper rate than their former representatives could be gilt. The trade in these grew, and was very considerable, until it received a check by extensive importations of French and Prussian examples, the style and beauty of which even the most ardent sticklers in favour of English brass cornices must admit; the colour is remarkably fine, the burnishing exceedingly brilliant, even on the tinselly metal from which they are made, while the lacquer or varnish with which they are protected from oxidation or tarnish is extremely transparent, but does not stand so well as English lacquer. In several of the examples imported, there is an opportunity for comparison as to price, arising from the patterns of Birmingham manufacturers having been copied either by cast iron dies, produced by casting from the originals, or by having dies sunk from them in steel. Admitting that in strength of material the balance was in favour of the original articles of Birmingham manufacture, still there was such a marked difference of price in favour of those of continental production as to be startling, and led to the enquiry if these could be sold by a retailer at the prices marked, at what price were they produced by the manufacturers at Paris and Isherlon? While every attempt to deteriorate the substantial character of English manufactures is to be deplored, in this age of competition, the importation of foreign metal manufactures must be met.

On the introduction of the Continental Stamped Cornices, there was the usual howl on the part of the local manufacturers; chaos had come again; the trade was done for in England. A little further reflection, however, led to an attempt to try if the imported examples could not be met by an article of local manufacture equally light and cheap. The effort was made, the result satisfactory, as regards reduction of price. In Birmingham are now produced stamped cornices equally light, and as cheap as those of Prussian manufacture, with the exception that the latter, as regards burnishing, exhibit less "rivelling," in all probability arising from a more careful preparation of the "forces," or internal support, or solid convex copy of the cornice on which the burnishing is effected, and a delicacy and lightness of touch, which distinguishes the manipulation of continental artisans, attributable to vegetable diet, light wine, and very small beer. On the contrary, English beef and beer give muscular force and power, difficult to restrain, and unconsciously demonstrated in opposition to will. The difference lies there; but if the proposition is reversed, it is equally difficult for the continental workman to impart to solid cast work the deep rich burnish recognisable in the kind of work last-named produced by Englishmen. As regards the "dipping" of the foreign examples, while the metal is evidently lighter in colour, apart from the colour of the varnish or lacquer used to protect the metal from oxidation, their surface displays a delightfully uniform, speckless, delicately "dead" effect, in all probability arising from a superior knowledge of chemistry and its practical application. With these exceptions, the English competitive examples are up to the mark, and may fairly take their place side by side. As has been already stated, many of the foreign examples are copies of Birmingham cornice makers' patterns, affording a means of comparison as to price; and it may be instructive to compare Birmingham prices of the year 1856 with the prices of the same articles produced after the introduction of the imported varieties, at the same time contrasting the value of the English against the German, premising, however, that in the last-named comparison the articles of English make were heavier, but by no means of such a weight as to account for the very great and apparent dissimilarity in price between the examples—metal only, no woodwork—price per foot:—

Birmingham,	1856.		1866.			English.		German.		
	s.	d.	s.	d.		s.	d.	s.	d.	
4½-in. Cornice ...	1	1 ...	0	6 ...	4½-in....	1	1 ...	0	8	per foot.
6-in. "	2	1 ...	0	10 ...	8-in. ...	4	4 ...	2	4½	"
10-in. "	4	2 ...	1	9 ...	8½-in....	2	10 ...	1	8	"

Manufacturers of finished Stamped Brassfoundry for Upholstery purposes are also makers of Brass Tube Cornice Poles; they are also makers of brass (three-fourths, and half covered on wood) poles, in which articles an equally great reduction in price has been made as in stamped window cornices. A two-and-a-half inch cornice pole, three-fourths covered, which originally cost 2*s.* 6*d.* a foot in 1840, can now be purchased at considerably less than half that amount. The metal is lighter, but the difference in the value of the metal does not account for the very great reduction in price, thus:—

	2in.		2¼in.		2½in.
	s. *d.*		*s.* *d.*		*s.* *d.*
1840	1 9	...	2 2	...	2 6
1866	0 11¼	...	1 1	...	1 2

The same manufacturers make also Cornice Pole Rings at a great reduction in price from the old prices in the year named.

	2¼in.		2½in.		3in.	
	s. *d.*		*s.* *d.*		*s.* *d.*	
1840	4 1	...	5 0	...	6 0	per doz.
1846	2 10	...	3 0	...	3 9	"

The three-fourths covered poles have the metal drawn on by the drawing process, similar to that to be described in tube drawing. A wood core or centre is laid in a strip of brass, rendered concave by passing through rolls. In this state it is taken to the draw-bench, the wood and brass drawn through a tool, the "tange" of the brass and wood being caught by the pliers of the draw-bench, and dragged in its entire length through the tool, the result is, the brass is made to cling to the wood. The brass is thereafter "floated," with floats, *i.e.*, files, with the teeth cut in one direction, the surface scoured with pounded pot, the pole is thereafter burnished with long steel burnishers; lacquering concludes the finish, and completes the pole. All brass poles are finished in the same way; but occasionally they are polished and lacquered. Cornice Pole Rings are made from tube, the ring form is given by winding the tube round an iron mandrill; the entire length of tube forms about one dozen rings. The oil is then sawn through longitudinally, which separates the rings, the joints of which are soldered, and the rings finished by turning and burnishing, the loops for the curtain hook rivetted in, and the rings are thereafter lacquered. Broad or flat rings for the same purpose are made from sheet metal, and raised convex by press tools. Stamped ornamental rings are also made for the same purpose. The first ring of the former variety was made by Mr. Thomas Horne. In making ordinary tube cornice rings, where the tube is made of thin sheet brass, the tube requires to be filled with sand in order to retain its cylindrical form in "winding," and to prevent the appearance of "puckering."

As *Dipping* is the universally adopted method of finish in Stamped Brassfoundry, the process will now be described. In connection with this department of brass manufacture, we have to record a curious incident which revolutionised this style of finish, and has extended itself into all other departments of the the finished brass trade. Previously, the operation of dipping or acid finish consisted in "pickling" the brass in weak acid, and thereafter passing the work through strong-dipping aquafortis, the result was a bright surface. The "dead dipped" process, which gives such a contrast to brilliant burnishing where introduced, arose originally from the negligence of the workman, whose special duty it was to "dip" the article. In the year 1832, a "dipper" in the employ of Mr. David Malins left throughout the night a quantity of articles in the cleansing solution, or pickle; the result was, that on attempting to produce the bright "dip" by immersing or passing the articles through the strong acid, they presented a dull frosted yellow surface or hue; charmed with the effect, certain portions were operated upon with the burnisher, and lacquered. Acting on the accidental hint, "dead dipping" was thus originated, and has now become the recognised and generally practised mode of finish where acid is employed.

The operation of "dipping" is practised as follows:—The shop is, or should be, a well-ventilated, high-roofed apartment, with abundant provision for the escape of the fumes of the acid. It is built round interiorly with brickwork, on which to place the tubs which contain the water to kill the acid, and the "jowls" or earthenware vessels in which the various strengths of acid are contained. There should also be a muffle in which to anneal the work, and a horizontal plate of iron with provision to heat it, in order to keep the box-wood receptacle or sheet-iron pan and its contents at a moderate temperature. This shop should be in connection with a space or yard in which to place the pickle troughs, and there should be ample provision for the supply of clean cold water; if soft water, so much the better; also a set boiler in which to keep hot a supply of ley or alkaline solution, as potash or soda. The materials employed are aquafortis of various strengths, pure water, and argol, *i.e.*, the refuse or sediment of wine casks, or crude tartar in the form of a powder. After annealing, the work is immersed in a weak solution of pickle, to "scale it," or remove the external skin. After rinsing it out, it is brushed with sand, to remove the more firmly adherent scales. Again pickled, if uniformly clean, it is then in a condition to receive a final finish, if bright dipped; and, if dead dipped, to be subjected to the "deadening" process, which is conducted as follows:—The aquafortis is reduced from its dipping strength by means of water, or a special variety is used and designated by the name of "deadening aqua." A quantity of either the former or latter is poured into a "jowl," or brown earthenware open-mouthed vessel. The articles are placed therein, and the jowl agitated till a creamy coating is observable over their entire surface; they are then removed and washed out in water. After they are cooled and the acid "killed" they are passed through the strong aquafortis, rinsed out in three several tubs of water, and then dried out in warm box-sawdust contained in the sheet-iron pan already alluded to. Any acid which may have accidentally insinuated itself into defects in the work is neutralised by immersion in the "ley" or alkaline solution contained in the boiler. After the articles are dried out they are then plunged into a tub containing pure water, on the surface of which is strewed a small quantity of argol, or tartar. In this condition the workman holds them in his vice, or, if round or globular, places them on the chuck in his lathe.

The operation of dipping is considerably dependent on temperature. It is retarded by cold, and accelerated by a moderate heat; in exceedingly hot weather it is with great difficulty accomplished, and is rarely satisfactory, as the work becomes speckled or irregular in the "deadening." The success of the operation of dipping is greatly dependent on the mixture of the metal, and not a little on the aquafortis, its strength and purity. Up to the present time practice has been the only guide to English "dippers;" the recurrence of certain phenomena they obviate by experience, by rule of thumb or experiment; and these experiments are not on all occasions successful in removing the difficulties which present themselves. Science, to be useful, should deal with the rationale of the operations and processes employed in manufactures; but no scientific work has yet explained the "why and because" which regulates the failure or success of "dead dipping."

To dipping follows burnishing, the process of which will now be described.

Burnishing, which furnishes a contrast to other portions of dead dipped work, is effected by means of steel burnishers, or tools of steel, varying in form according to the nature of the work and surfaces of the portions to be burnished. For ordinary flat work, or tubes and the edges of cast work, the burnishers are from twelve to fifteen inches long, of oval shape, and tapering to a point. Other varieties of burnishers, as for lathe burnishing, are made with variously formed terminations; others are hooked, and of various breadths and thicknesses; all are blunt, and after being hardened are polished up to the highest degree of brilliancy on the portion used for burnishing. The article to be burnished is held in a vice, if cast; if stamped, it is laid on a "force" or solid metal convex brass or lead cast of the stamped article; this furnishes an internal support to the thin metal, and prevents its sinking under the pressure of the burnisher. The surface to be burnished is operated upon with the steel burnisher, dipped in "ox gall." This lubricates the burnisher, and prevents scratching. The work, when it gets dry, is dipped into the argol water. When the article has been burnished on all the portions intended, it is passed through "sharp water," *i.e.*, water in which a small quantity of acid has been mixed, thereafter it is rinsed out in pure water, and finally dried out in warm box-sawdust; it is then lacquered to protect it from oxidation or tarnish.

As Stamped Brassfoundry is always lacquered, a description of the process of lacquering is here introduced.

Lacquering, or the covering of finished brass work, with transparent varnish to preserve the surface and finish of the articles from ordinary and extraordinary atmospheric and other influences, may be said to complete the manipulatory operations in the manufacture of objects in brass. The lacquering room, in the best regulated manufactories, is a lofty, well-aired apartment, with counters round, on which to lay the finished articles. In it are erected, on brick basements, with cast iron top or plate placed horizontally like an ordinary hot-hearth, one or more stoves. Ordinary cast-iron frames and doors are inserted in front to allow of the introduction of the fuel. A series of flues running under the surface of the iron plate secures the diffusion of heat generally on its upper surface. On this plate are laid the articles to be lacquered. The Lacquer or varnish is composed of spirits of wine, in which has been dissolved seed lac. In appearance it presents that of pale French brandy, verging, where coloured, into that of the brown variety of the spirit already named. Turmeric, dragon's blood, or sandal wood, will impart various shades of colour if dissolved in the mixture of spirits of wine and lac already named. The brass articles having been coated over when cold with the lacquer, are laid on the hot iron plate, and when sufficiently heated are again coated with lacquer applied with large round camel hair brushes, of sizes varying from five-eight inches to one inch diameter. Delicate and skilful application, and the perfection of lacquering, consist in a uniform coating. Careless lacquering is indicated by smearing or irregular depths of shade, and consequently impaired brilliancy of effect. Too much heat frizzles the lacquer; if too cold the articles will be dull. The spirit of wine is simply a solvent for the gum, and when the lacquer is applied evaporates or flies off, leaving the gum on the surface of the brass, and protects its surface completely for years from ordinary exhalations or other influences. Sea-air, the noxious fumes of chemicals or tobacco, the deposits of flies, damp, &c., however, act upon it, and corrode through the lacquer, impairing its brilliancy and protective properties. The idea that lacquering brightens up brass work, apart from finish, is an error too frequently entertained; unless there is previous finish, lacquer being transparent serves only to render more apparent the existing defects on the surface of the object on which it is applied.

Attempts have been made to introduce steam-heated lacquering plates, or a hollow iron box into which the steam passes. Heat in steam, however, indicates pressure, and no ordinary engine boiler valve could be so loaded as to stand the pressure to get up the required degree of heat equal to that produced by fuel introduced immediately under a cast-iron plate.

Steam has, however, been successfully applied to the lacquering of tubes and other hollow articles as follows:—a steam pipe is conducted from the boiler of the engine connected with the works, this pipe is led into the lacquering room, and placed horizontally about three feet or three feet six inches from the floor. In this horizontal tube is inserted, at regular distances, a number of good, well made gun-metal taps; these are fitted with lever keys, easily removed after the steam has been turned on or off. The taps have tapering ends, which are inserted into the end of the pipe or tube to be lacquered. The opposite end of the tube is supported on a stand, the steam is turned on, passes through the interior of the tube, and speedily heats it to a sufficient temperature for lacquering. The lacquer is then applied as already described. For the purpose of lacquering such articles as have been named, the steam method alluded to has no equal. The heat of the tube, or hollow article to be operated upon, can be increased or diminished at will by simply turning on more, or checking the admission of the steam.

Contrast this with the tedious process of heating a twelve or eighteen feet tube, or hollow cornice pole, on a cast-iron plate. The utmost length which could be properly heated at one time would not extend beyond eighteen inches or two feet. We have thus at least twelve separate heatings; removed from the hot plate the article speedily cools, and we have nine or twelve separate joinings of lacquer; the lacquerer must be careful and skilful indeed who is able to conceal the junctions of the several points of contact. If this is contrasted with the tube regularly heated by steam, the superiority of the steam process will at once be recognised.

STAMPERS IN THE ROUGH, AND FOR HIRE.

Having hitherto dealt chiefly with finished stamped Brassfoundry for sale to upholsterers and decorators, another equally important department of the stamped trade remains to be treated of, viz., the class of articles produced and consumed by manufacturers of cabinet brassfoundry, gas fittings, and brass bedstead makers, who either have not dies or stamps wherewith to produce stampings, or who desire to vary their patterns by the infusion of a little variety, which are supplied by "Manufacturers of Stampings in the Rough." There is yet another section of the stamped trade, viz., that of "Stampers for Hire;" these do not possess dies of their own, though they have all the appliances for stamping. In the latter, the dies and metal are sent by the manufacturer; after the stampings are completed, they are returned with the scrap and dies, the stampings being charged at so much per gross or per dozen. The former class sell their work at so much per gross or dozen, the price of the metal included. In the condition in which the Stampings are sold they are unfinished, being left without the oxide or skin on their surface being removed after annealing, and from the last blow of the stamp. For gas fitting purposes, Balance Weights, Vases, Bodies, Arms or Branches, Ceiling Plates, Chain Links, &c., are produced. These are converted or fitted up into chandeliers, by the manufacturer, workmen adding the structural parts, introducing the tubes which conduct the gas to the burners, and forming the necessary attachment to connect the stampings with the other portions of the chandelier, &c. The article is then taken to pieces and finished by lacquering or bronzing as may be desired. Recently, a considerable improvement has been made in the "stamped rough trade" by manufacturers engaged in it sinking entire sets of dies to produce chandeliers, &c., *en suite;* formerly they simply produced only incongruous parts, and the consequence was an article in which a mixture of styles was too apparent. Admitting the effect of stamped work never can be compared to good honest casting, in so far as substantiality, and light and shadow, consequent on under-cutting, are concerned, still a very near approximation to the effect of cast work may be arrived at by the attachment of leaves, ornaments, or portions of ornaments stamped separately, and soldered with hard solder to the other parts of the stamping it is intended to enrich. The present demand for articles good in form, decorated with ornament in low relief, is favourable to the stamping process, in so far, that while the die in which the article or portion of the article to be stamped is more easily sunk, the stamping of the metal is accomplished with greater facility if attention is paid to the "force," owing to the ease with which the "force" is withdrawn by the stamper after the blow has been struck. The conditions involved in the preparation of a die for stamping, necessitate that it should be so cut or tapered in the work, in order that the metal can be easily withdrawn after it has been struck into the die. If undercut, the metal would be driven into the undercut portion of the die and held there. Every incision or depression in the die must therefore be tapered outwards towards the top of the die, so that if a cast in plaster was taken from the die, the cast would readily drop out on reversing the die. It is the necessity for attending to this condition which lies at the bottom of want of effect in stamped work of all kinds, and makes it contrast so unfavourably with "beaten works," which there is no doubt stamping was intended to imitate.

Within the last few years very large ceiling ornaments, made in brass, have been introduced instead of "plaster," "papier maché," and "compo," for the decoration of centres of ceilings of rooms, &c. These are produced by stamping in separate leaves, and uniting the several portions together. The stamped work produced for bedstead makers consists of vases to surmount the pillars, capitals, and bases, centre husks for pillars, rosettes, and other portions for the decoration of head and foot rails.

The process of stamping will now be briefly described. The mechanical requisites are a stamp formed of a heavy mass of cast iron, which is sunk into the ground. From this, two cast-iron uprights or pillars rise. On the top of these is a transverse piece of metal, with an aperture in the centre, over which a pulley works. Over this pulley, with a groove in it, a rope works; to one end of the rope is attached a hammer or "ram," which slides between the pillars, which act as guides; the other end of the rope is left free, and is used to raise the hammer. The die is attached to the bed of the stamp and held there by four screws; to the pulling hammer a "force" or convex copy of the die is attached. The piece of sheet metal to be stamped is laid on the die, the hammer is elevated by pulling the rope, it is then allowed to descend; the consequence of the blow is, that the metal assumes the approximate form of the concavity sunk in the die. If the reader imagined that the production of a stamped article was effected by one blow, he would labour under a mistaken impression; even an article in low relief requires seven or eight blows, and a corresponding change of "forces," increasing in convexity and in the amount of detail, until the entire design in the die is brought up. While seven or eight blows have been named, certain articles require as many as twenty or twenty-five blows to bring them up with all the details perfect. If expedited by diminishing the number of blows, the chances are, that the metal operated upon would tear, crack, or "fly," in the process of stamping. In the process, the metal is repeatedly annealed to restore its ductility. The last blows are given from brass "forces," with all the details perfect, the "taking down" being effected by lead, tin, or softer metal forces. If the description given of the process of stamping has been understood, the idea of the difficulty of producing globular articles, as the balance weights of chandeliers and certain varieties of cornice ends, will naturally suggest itself. Such are, however, stamped in two or more parts; the two parts which form an object are then made to fit each other, and bound together with binding wire. Borax and solder being applied, the union is effected by the action of a soldering stove or a hearth, the fire of which is operated upon with bellows, or the gas blow-pipe effects a similar result. The surplus metal and solder is then trimmed off, and the balance weight or portion of the cornice end is in a condition to be passed into the hands of the fitter and finisher.

A recent introduction of improved appliances for the production of large-sized vessels by stamping in metals, as copper, &c., has been made by Mr. Daniel J. Fleetwood, and merits attention. In it the united power of water and steam, &c., is taken advantage of for the production of purely cylindrical forms by the forcing down, or out of the flat discs of metal, cylinders of various depths with flat flanges or vessels with ornamental mouldings on top and bottom, dish-covers, &c. The upper and lower dies are moveable, the upper operated upon by steam, the lower by the equally irresistible force of hydraulic pressure, and a ring partaking of the character of the external ornamental form of the vessel which is akin to the "force" in ordinary stamping. This steel force is operated upon by a piston-like die, or hammer, which it surrounds annularly, (it is a collar, in fact). The down blow of the piston-like upper die strikes on the surface of this force, which in turn operates on the copper disc, and it gradually impresses on it the contour of the mouldings. No annealings are required, and the advantage is, that the metal of the vessel is formed uniform throughout, and not as in that process in which the disc is held, and the metal drawn, or forced down by pressure, in which case the sides of the vessel must be thinner. In the Fleetwood process, each blow takes in a little more metal, and the metal is drawn in or "swaged down," not forced down, thus preserving a greater thickness on the sides of the vessel than can possibly be done by "the cam" operation method. By the new process, the "dies" or "anvils" can be withdrawn, and the stamping taken out. If two sets of dies are being worked, as they can be, two workmen may be employed, as a clever arrangement of a railway permits of dies being withdrawn, one workman dislodging—withdrawing his die—and taking out the stamping, while the other, having placed his die under the stamp, the operation of stamping is proceeded with, and no time is lost. This method of stamping effectually does away with "repeated" annealings, changing "forces;" and work which could only be produced by a great number of successive operations, and at a great expenditure of time, is now reduced to a minimum as regards time and cost. For large objects, cylindrical in form, with ornamental mouldings on the upper surface, as large cooking vessels for the Turkish army, of which immense quantities have been made in Birmingham; for dish covers, &c., the process is invaluable. The application of two forces to effect one operation is original, viz., the hydraulic force which impels up the lower die, and the pulsative force of steam which operates on the upper die or hammer which strikes the blow on the collar or annular die, and produces, in semi-ornamental work, the mouldings. Of course it will be readily understood this process is confined to the production of such work as has been named.

All stamped articles have surplus metal attached to them after the stamping process has been completed, which is got rid of, where the number of the articles is not very great, by means of thin chisels. When the stamping is laid in the die, removed from the stamp, where articles are numerous, "clipping tools" are made of the exact contour of the outline of the die, the bed placed in the press and held there, the punch is attached to the screw of the press, the lever gives motion to the screw, causes the punch to descend, and cuts away the surplus metal by one operation.

The process of stamping, when conducted by manual labour alone, is a laborious one, involving in the raising of the "ram" or falling hammer, frequently 112 lbs. or more in weight, the unnecessary expenditure of muscular labour. The application of steam "power" to the process, while it has been taken advantage of by the manufacturers of stamped tea tray blanks, dish covers, and large articles to be electro-plated, by tin-plate workers, and by manufacturers engaged in the production of large copper goods, with one or two exceptions, has not yet been generally adopted by stampers engaged in the production of stamped brass goods. The steam hammer of Nasmyth, with its immense power, capable of such delicate adjustment, certainly furnished the hint; and one manufacturer, Mr. Joseph Hill, of Broad Street, patented a steam hammer with certain improvements which fitted it for brass stamping. One or two other manufacturers have adopted methods by which the "ram" is lifted by belts passing over pulleys attached to a shaft set in motion by steam, but the great majority of the trade continue to use manual labour only. They are slow to recognise the waste of nervous energy and muscular strength in a process which can be better accomplished by the inanimate and untiring power of steam. By retaining the old method of working, they ignore the science of the nineteenth century; this, advancing intelligence repudiates, and humanity deplores. One diligent manufacturer of stamped brassfoundry in the rough informs us that the labour, by the pulley-revolving-by-machinery process, is diminished by one-third; what was done by the stamper and two "pullers" is now done by the "stamper" himself. He elevates the "ram" with ease himself; in another stamp worked by one man, the pull is effected with the use of the arm only. A little prejudice existed on the introduction of the process by the workmen or stampers, but this has now been dissipated, and the process is preferred.

In connection with stamping in the rough, that of "Piercing" is also practised. This process consists, in addition to that of cutting away the surplus metal from the stampings already described, in perforating various apertures n work already stamped, as for example, the border which surrounds an Argand burner, or the coronas which have been recently introduced to surmount shades in connection with terra cotta tops. These perforations are all made by cutting out and "piercing" from sheet metal with "beds" and "punches." In cutting out such coronas, &c., frequently there are several sets of tools and corresponding punches required to produce one pattern. The best and most familiar illustration of the process of "piercing" which can be given is that of the ordinary paraffin burner, *i.e.*, that part of a paraffin lamp which is attached to the receptacle which contains the hydrocarbon oil, and through which the wick rises. Such burners are made entirely out of sheet brass. Each burner requires, in some examples, the operation of thirty-five different pairs of tools to complete it, involving thirty-five distinct changes of tools, and a corresponding number of manipulations. A somewhat similar process was practised in the early days of the manufacture of finger plates, in their transition stage between casting and stamping; and when they were made by casting, before stamping was introduced, they were then perforated; but as brass cast is by no means so solid as brass rolled, the perforations were cut out as described in the process of piercing. As, however, the latter were entirely formed of flat sheet brass, the pattern was produced by a process now but seldom used, viz., that of "book piercing." In this case the bed had the entire design cut in it; to it was attached a thin plate, as the boards of a book; this was also a copy of the "bed." To each of the perforations a piece of steel was fitted, corresponding to the apertures in the beds. The operation was performed thus:—The piece of rolled or sheet metal to form the finger plate was laid on the bed, the perforated cover was dropped over the sheet metal, and the several punches or formed pieces of steel arranged in their corresponding spaces. These punches projected above the surface of the board when arranged. The bed, metal, and cover were placed under a press, the handle turned; the operation of the screw compressed the heads of the punches, forced them through the metal, and the perforations were completed. The same routine followed until the quantity of articles desired were completed. The same method is followed in perforating ornamental strips of metal for letting into wood furniture, for decorative purposes, as that now known as "buhl work," and associated with tortoise-shell and various kinds of ornamental woodwork. It was also used in fender making, to produce the ornamental perforations which at one period formed their decorative enrichments.

Among the curiosities in stamping and piercing, the writer of this has to record that some years ago he had placed before him for reproduction a number of patterns of head ornaments in brass, made by a native African worker in metal (no doubt cut out at a vast expenditure of time, by means of small chisels, and ornamented by numberless blows from punches), which in a very singular manner confirmed the peculiarity of the ornamentation of savage tribes, so well illustrated in the work of Mr. Owen Jones. The whole of these patterns were decorated on the principle of geometric figures, as circles, squares, and combinations of angles—save one example, in which coral was taken advantage of as a type; but it was conventionalised into a graceful and harmonious arrangement, perfectly balanced and symmetrical. The only surface ornamentation was a series of externally elevated dots punched up from behind, which followed and displayed the lines of the perforations, thereby illustrating the intuitive perception of ornament in the mind of the savage. The complicated and involved forms in the originals, necessitated for their reproduction the making of a large number of cutting-out or press tools. These once made, the process of reproduction was reduced to the minimum of time and cost, the dotting being produced all over the surface by one blow of the stamp, thus furnishing the Banyan importer on the coast of Africa with new examples of decorative enrichments for purposes of sale, or barter, with the natives from the interior, with which the investigations, consequent on the travels of Burton, Speke, Livingstone, and Baker, are daily rendering us more and more familiar.

In the stamping and piercing trade a very considerable amount of female labour is taken advantage of. The tools are fitted into the press by tool makers, who also attend to the condition of the tools in cutting out the larger examples of stamped work from the scrap which surrounds the stampings. Women work even the large presses, leaving to girls the cutting out of smaller examples of work, as chain-links, blanks for rollers, &c. Frequently the cutting out of the large examples alluded to is very laborious, involving a considerable amount of strength, which renders it questionable whether the occupation is one quite in unison with the employment of female labour.

The labour in the stamped trade is performed by **stampers**, who realise, according to ability, from 20*s*. to 25*s*. Experienced stampers of ability get, by the piece, from 30*s*. to 40*s*. per week; men, who simply raise the ram of the press, 15*s*. to 18*s*. per week; lads, from 7*s*. 6*d*. to 10*s*. per week; boys, who, "cob" the work, brush off the scales, place it together, and do small stampings, 3*s*. 6*d*. to 5*s*. 6*d*. per week; annealers of the work in process of stamping, who attend to the muffle, 15*s*. to 18*s*.; fitters together of the work, to prepare it for dipping, and burnish it, from 20*s*. to 30*s*.; dippers, from 20*s*. to 25*s*.; lacquerers (women), 8*s*. to 10*s*.; girls, from 3*s*. 6*d*. to 5*s*.

In "piercing" and cutting out, where women and girls are generally employed, and where the progress of the work is superintended by a workman or tool maker, he gets from 30*s*. to 40*s*. per week. In addition to making tools, he sharpens and sets the tools in use. Women get from 8*s*. to 12*s*.; advanced girls, 6*s*. to 8*s*.; young girls, 3*s*. 6*d*. to 5*s* 6*d*. As regards the payment of women, some of them take out the work by piece occasionally, and realise more money than is named.

Rolled Metal, Wire, and Tube Making will next engage our attention. In the manufacture, the consumption of raw material, *i.e.*, copper and spelter, is very considerable; the united results form no inconsiderable item in the exports of the United Kingdom, especially as regards yellow metal sheathing.

5.—THE MANUFACTURE OF ROLLED SHEET BRASS, BRASS AND COPPER WIRE.

Sheet brass is the "latten" of the older writers, a term constantly used in archæological treatises. It was in this form that the metal brass was chiefly imported into this country from the continent in early times, and until the manufacture of brass was established in England, and was produced by the Battery Works. Some of the slabs, chiefly for ornamental purposes, especially those imported from the middle of the twelfth century down to the fifteenth, were, however, cast, or cast and hammered, as an examination of them shows. The Chinese still continue to cast their plates, or slabs of thin brass, their patience united to their skill, serving them for the rolling mill of the "barbarians" of the new world. It should be understood, that in order to produce a thin plate of brass, even so thick as $\frac{1}{8}$ or $\frac{1}{4}$ of an inch of say 4 feet by 3 feet, a surface of sand, or sand mould of such a size could not be expected to stand the requisite pressure, but becomes convex in the middle. The consequence is, that the plate when cast is unequal in thickness, thin in the centre, or the metal becomes congealed owing to its want of body, and the slab or plate when cast is deficient in solidity, in so much that the most skilful hammerman could neither hammer it solid, flat, or equal in thickness. If the difficulty exists in reference to the production of metal of the thickness named, how much is it increased when sheet metal of the lower gauges, some of which is scarcely so thick as ordinary writing paper, is required, as it is for many of the Birmingham trades. It is here the great importance and value of the rolling mill is shown, the "strip caster," and the irresistible power of huge rolls set in motion by the mighty power of steam. Without the rolling mill, the Birmingham brass trade would be small indeed. Rolled brass is the semi-raw material on which the stamped brassfounder entirely depends; without it, ordinary soldered brass tube, patent cased tube, or cased stair rods could not be made. It largely enters into the productions of the cabinet brassfounder, of the door, shutter knob, and cupboard-turn maker, of the drawn and pressed brass hinge maker, and brass covered cornice pole maker; in truth, it would be extremely difficult to state in what department of the brass trade it is not consumed. Immense quantities of rolled metals are required in the manufacture of the domes and mouldings of locomotive engines, and for other engineering, useful, and decorative purposes. Not the least attractive features of the shops of our large cities and provincial towns are derived from the brass plates on which are engraved the names and businesses of the proprietors, and the brilliancy of the plate glass of their windows is increased by the brass-covered sash bars with which it is associated. Even writing paper, so smooth and glossy of surface (as much of it now is), receives its finish from bright rolled brass plates; and lastly, in imitation of "brass" and "slab" of the olden time, on enduring brass we commemorate the memory of departed friends, of genius, talent, and public usefulness, gone from among us.

The processes involved in the production of sheet brass differ from those of cast brass very considerably, in so far as the moulds in which the strips of brass are cast, afterwards to be rolled. These are not formed of sand, but of cast iron for the ordinary purposes of Birmingham manufacture. Larger ingots for sheets of greater dimensions, are formed of slabs of granite.

In either case, before pouring in the metal the interior of the ingot moulds is coated with oil and charcoal powder. The ingot mould in form resembles a shallow oblong iron box, with lid, and after the operation of coating (as described) has been gone through, the lid or cover is placed on, and the two parts of the mould held in their position by one or more iron clamps. The ingot mould is placed perpendicularly, and one end of the mould being left open, is that into which the melted metal or brass is poured. Considerable skill and experience is required in the formation of the ingot mould; if either too hollow or too convex in the centre, the strip produced fails to roll satisfactorily. The ingot being cast and found solid, is presented to the first pair of rolls, technically, "breaking down rolls." In Birmingham, these are set in motion by steam, and in their revolution pinch and drag the strip through, considerably reducing it in thickness and increasing its length. This operation is repeated until the strip has become so hard as to require annealing to restore its ductility. The annealing operation is conducted in huge reverberatory furnaces or muffles, which the heat of the fuel raises internally into a vivid red heat; these are closed by an iron door. On the introduction of the metal, the door is closed, and after a few minutes is opened, the strip has become of a blood-red heat, the annealing has been effected, the ductility of the metal has been restored, and the strip is carefully withdrawn. After being allowed to cool it is again passed through the rolls, and the operation of annealing repeated, until the requisite thickness or gauge has been nearly arrived at. The elongated strip, which is now twenty or thirty times its original length, but which has not increased in breadth, is immersed in cleansing pickle, or a solution of sulphuric acid, it is then rinsed out in clean water, dried, and if desired of bright smooth surface, is finally passed through bright polished rolls. "Spilly" metal occurs when thin portions rise up on the surface in process of working, or slight convex elevations appear—these imperfections arise from the imperfect casting of the "strips." Two qualities of sheet brass are made, one in which the metal approaches to the quality of "common fine" or dipping metal, and will solder; another but cheaper variety which will not solder, or, as it is technically said, will not stand the fire, *i.e.*, its melting point is below that of ordinary spelter solder. Such metal is fitted for work that does not require jointing or uniting, except by means of hard solder, which runs at a low temperature, but which, when run, will not permit of being hammered in connection with the pieces of the metal it partially unites.

YELLOW METAL SHEATHING, BOLTS, NAILS, AND WIRE.

Next to the solid tube trade, but superior to it in the amount of copper and zinc, or spelter, consumed in its manufacture, is the yellow metal trade, or the manufacture of Yellow Metal Sheathing, Bolts, Nails, and Wire, for ship-building purposes. The late George Frederick Muntz, Esq., M.P., has hitherto enjoyed the reputation of being the inventor of this mixture; at all events he has been considered the discoverer of this now important branch of brass industry, by which copper, largely alloyed with zinc, has superseded the application of sheet copper for the protection of ships below the water line. If, however, the merit of introducing a large percentage of zinc with copper for the purpose is to be regarded as forming a claim to protection, Mr. Muntz's claim to be considered as an original inventor is of the most shadowy character imaginable. So far back as 1779, a Mr. James Keir patented a metal, "capable of being forged or wrought when red *hot* or cold, and more fit for making bolts, nails, and sheathing for ships, than any other metals previously applied for the purpose." Its component parts were one hundred parts of copper, seventy-five parts of zinc, and ten parts of iron. The copper and iron were first melted and mixed with charcoal and pounded glass, and the zinc then added. In 1800, a Mr. William Collins obtained a patent, which claimed three alloys of metals for ship sheathing, *i.e.*, red, yellow, and white; the yellow, consisting of *one hundred* parts of copper and *eighty* parts of zinc, producing a metal which could be rolled at a *low red heat*. It will be seen by comparison that the mixture of Muntz's sheathing is a wide one, varying from *fifty* up to *sixty-three* per cent. of best-selected copper, with *fifty* down to *thirty-seven* per cent. of zinc. Keir's sheathing metal mixture, if divided by half, gives *fifty* copper, *thirty-seven* and a half zinc, and five iron; and Collins's, *fifty* copper, and *forty* zinc. The merits of Mr. Muntz are therefore reducible to the resuscitation of a dead process, or mixture only.

At the meeting of the British Association in Birmingham, in 1849, Captain James, R.E., of Portsmouth, detailed a series of experiments he had entered into, as regards an infusion of phosphorus into copper for sheathing purposes, prepared for him by Dr. Percy, in 1848, which he showed resisted the action of sea water in a greater degree than pure copper. Messrs. Alexander and Henry Parkes had, however, in the year 1848, protected the incorporation of phosphorus with metals, for the purpose of improving their density, solidity, and adhesive properties. In 1857 they patented for ship sheathing, copper and its alloys with zinc, in combination with phosphorus, or metal manganese, to enable, as they state, the sheets *to be rolled hot.* The last named quality, it will be observed, is no new feature, as the sheathings of Keir, Collins, and Muntz, were all capable of being rolled hot. The proportions of the mixtures of Messrs. Parkes were six ounces of phosphorus, one hundred pounds of copper; or four ounces of phosphorus, sixty pounds copper and forty pounds zinc; or four to six ounces of manganese, and one hundred pounds copper. The flux used to melt the manganese with the copper is carbonaceous matter or charcoal. Advanced chemical science has hitherto failed to show in what way the phosphorus acts; whether as a superior flux only, or whether it enters into combination with, and imparts the quality to the metal which is claimed for it. Dr. Percy maintains it does not resist the action of the sea water better than sheathing of the ordinary composition.

It may afford some idea of the importance in which the manufacture of Yellow Metal Sheathing is held, commercially, when it is stated that after the death of Mr. Muntz, the trade and works were purchased from his son, G. F. Muntz, Esq., by a Joint Stock Company Limited, and upwards of £40,000 paid for the goodwill alone! But it was one of the great prizes drawn in the lottery of patents. How it resisted the crucial test of Courts of Law, to which, in common with some other patents, it was subjected, is matter for wonder; and equally so that a renewal of the patent should have been asked for, after the sum of at least £68,000 had been realised thereby. The remuneration was surely ample; for it is impossible to believe that either mental labour, pecuniary means, or protracted experiments were involved therein. The writer of this heard Mr. Muntz—at a dinner got up to celebrate the inauguration of the New Patent Law, in 1852—declare, as a set-off against the cost stated by a speaker as consequent on experiments preparatory to taking out certain patents, that the preliminary expenses incurred by him on his ship-sheathing patent, cost him the munificent sum of 8*d.*! It is doubtful with Collins's specification before us, even to assign it the dignity of a "new manufacture." It was one of those patents which may be placed among the categories of Patent Law enigmas, which have been the means of originating opposition to a law conceived for the protection of inventions and inventors. Such patents indicate the necessity for a special Court for the trial of such cases, composed of scientifically educated legal men, aided by practical men or "experts." By such means only can doubtful patents be tested. As the reviver of an old patent Mr. Muntz is entitled to consideration, and on these grounds only. Now, with the printed specifications for consultation, such a patent could not have stood the test of a Court of Law, and no patent agent would have been justified in taking it out.

The large quantity of zinc in proportion to the copper, and the property of the mixture permitting its being rolled hot, are so many elements which enable the yellow metal sheathing to be sold at a cheap rate, in proportion to the price of copper sheathing. When partially decayed, it is received back and exchanged for new, an allowance being made for the old sheathing. Tough cake copper being £86 per ton, the price of yellow metal sheathing is as follows:—Sheathing and bolts, 8½*d.* per lb.; nails, 10½*d.* per lb. In exchange, old metal taken back—metal and bolts, 2*d.* per lb.; nails, 4¾*d.* per lb. But its price varies with that of copper and zinc at the time the sheathing is sold. The production of sheathing, ship bolts, nails, and wire, made of the Muntz's mixture, amounts to 11,000 tons per annum in Birmingham alone; the value of which may be roughly estimated at £800,000, produced by the five manufacturers engaged in this town. Yellow Metal Sheathing is also produced in South Wales.

The processes involved in the production of Yellow Metal sheathing, &c., are very simple, and consist in melting the copper and spelter in a reverberatory furnace. Very generally, old sheathing forms a part of the mixture. Before pouring, tests are instituted which are necessary, as the too great heat of the furnace may have led to the volatilisation of the zinc. When found correct, the metal is drawn off by means of iron ladles, coated internally with clay, the contents of these are emptied into large ingots of cast iron, or "strip" ingots as they are called, the strip casts are then rolled out hot; this being a quality which yellow metal possesses over ordinary sheet brass, (which is rolled cold), and materially reduces its cost. Immense and ponderous rolls compress and elongate the semi-plastic ingots into the thickness required, the bolts are cut from thick strips and drawn or rolled. Wire of this metal, of which considerable quantities are exported, is made by the process already described in wire drawing. Bolts, nails, and wire are subjected to immersion in sulphuric acid pickle, from time to time, and being washed out in pure water, and then dried, the operation is complete. A very large amount of yellow metal sheathing, sheet brass, and wire, is exported to India, amounting to 15,764 tons in 1864, and to 9,453 tons in 1865. A considerable amount of this metal must be consumed in making brass cups which serve the purposes of gloves, and Memorial cards, in England. The funeral of every Hindoo, we are told, increases the consumption of brass, according to his station, the relatives of the deceased giving a brass cup to every Brahmin present at the funeral, so that various numbers of cups, from five up to a thousand, and sometimes the last number multiplied by ten, are distributed on such occasions, according to the rank and standing of the departed.

Between three and four hundred workmen, it is calculated, are employed in the metal rolling trade. Head rollers take out the cast strip and roll it at so much per cwt. They realise from 40*s*. to 50*s*. per week; reducers of the metal get from 20*s*. to 22*s*.; finishers of the metal, 24*s*., 26*s*., and 30*s*. per week; mufflemen, 8*s*. to 10*s*.per week; lads, according to age and ability; Casters of strips are paid per cwt., and realise good wages.

The manufacture of Copper and Brass Wire merits a brief allusion, in so far as the consumption and manufacture of both are very considerable in these days of telegraphic communication. The former is of the utmost importance, and some idea of the productive power of the Birmingham brass and copper wire drawers will be gathered by reference to the Atlantic cable, attempted to be laid in August, 1865. The copper wire used in its construction was produced by two houses engaged in the manufacture, *i.e.*, Messrs. Bolton and Sons, and Messrs. Wilkes and Sons. The central core or conducting part of the cable consisted of seven copper wires of 18 W.G. thickness—these were twisted together into a strand of 10 W.G. The copper consumed in making the wire for the cable shipped, which in length was 2,300 nautical miles, weighed upwards of 690,000lbs.,or 308 tons. 0 cwt. 2 qrs. 24 lbs. The seven united wires which formed the strand in the centre of the cable, if placed end to end, would have reached to a distance equal to 16,100 miles. If we add a little more than half the quantity named, it equals the circumference of the earth (25,000 miles). Wheatstone calculated the speed of electricity as 192,000 miles per second, and the rate at which information can be transmitted as from thirty-five to forty-two words per minute. Did Shakespere, 300 years ago, when he made Puck say, "I'll put a girdle round the earth in forty minutes," anticipate the coming of the time when time and space should be all but annihilated by means of the Electric Telegraph? The possibility of producing the material for the girdle is amply demonstrated, granted the accomplishment of the laying of such girdle, and Puck's forty minutes would be reduced to one minute! While we write, cable No. 3 is being deposited in the waters of the Atlantic. The copper wire in this, as in the former cable, has been produced by Messrs. Bolton and Sons, and Messrs. Wilkes and Sons.

In the manufacture of copper and brass wire, for the former, the raw material is purchased from the copper merchants in the form of a partially rolled copper strip of considerable length, of ⅜ or ½-in. in thickness, which is then rolled down to the thickness suitable to produce the wire, then slit by means of what are called slitting rolls, *i.e.*, by means of a series of steel discs, which operate as revolving cutters. A pair of these slitting rolls are so constructed that the discs of one roll fit into the corresponding spaces of the other. These rolls are set in motion by power, and on the rolled strip being presented to them, it is dragged in, and slit longitudinally into as many "strands" of equal breadth as there are revolving discs or cutters; the "strands" are, of course, square. These are converted into round wire, by being drawn through a succcession of draw plates, or holes of various sizes, diminishing in diameter. This is effected as follows:—Attached to a long shaft operated upon by power, are a series of bevelled pinions or wheels. In connection with these, and working horizontally, are a number of cast-iron drums, corresponding to the pinions which are made to revolve by means of corresponding bevelled pinions. The drums alluded to have on their upper surface a small clamp operated upon by a screw. The "strand" is reduced at the end by filing, so as to enter and pass through the hole of the draw-plate. A pair of pincers, operated upon by power, draw the end of the strip sufficiently through, and in length sufficient to permit of its being attached to the clamp. The end of the "strand" is presented to the clamp, the screw is turned; the "strand" attached; the draw-plate is placed behind the two "snags" or pieces of iron which stand perpendicularly on the draw bench, the strand being placed on a reel. The drum is thrown into "gear," revolves, dragging through the strand, and converting it from a square into a round wire. The operation of drawing hardens the wire, and in the process of reduction it is repeatedly annealed. It is necessary to remark that if brass wire were drawn and forthwith subjected to the operation of the heat in the muffles, the result would be that it would fly or break into thousands of pieces. Before, therefore, it is placed in the muffle, the drawn coil is taken up in both hands by the assistant wire drawer, and struck violently on a wooden block. This operation expands the outer particles of the brass on the surface of the wire, and allows for the expansion of the interior particles.

Engineering experience has demonstrated that iron, subjected to vibration, is changed from a fibrous to a crystalline texture; and the same alteration or phenomenon is observable in common brass wire, which becomes disintegrated by exposure to action of the atmosphere. The brass wire guard crumbles; the brass wire chain in use in common gas-fittings, to suspend the balance weights, &c., frequently gives way without notice, and, if no injury is done, is, at least, productive of serious inconvenience.

Brass wire, like sheet metal, is made of two qualities, one which will stand the fire, with a greater per centage of copper, and a second quality which will not, the proportion of zinc in its composition being greater. Brass wire, in its earlier stage of manufacture, is produced not from strips purchased out, but from strips cast in the manufactory where the wire is drawn. The strip is rolled out, and slit into strands, as already described. In drawing both copper and brass wire, the strands are lubricated with grease or oil, to prevent their cutting. The final operation, in both cases, is to clean the wire by immersion in acid, and then to rinse it out in clean water. If for soft wire, the acid finish is left; if for bright, the wire is again drawn through the tool, which imparts to it the bright appearance it presents, and with which we are familiar.

There is no doubt that in the early stage of wire manufacture, it was drawn out by means of the hammer; afterwards came the operation of drawing or pulling through the tool by hand. Rudolf of Nuremberg, somewhere about the middle of the fourteenth century, was the first to introduce the present system of wire drawing. Readers familiar with the processes of ornamentation, will recollect the advantage taken of wire in precious metals for decorative purposes, as in the production of filagree work. The art of wire drawing by machinery, as regards brass and iron, was eventually introduced into England by Christopher Shutz, about the seventh year of the reign of Queen Elizabeth. "Previous to that period all English wire was made and drawn by men's strength." In the seventh year of the reign of Charles the Second, English brass wire was sold at £8. 8*s*. per cwt., and

Swedish brass wire at £5 5*s*. per cwt. The latter price, it is said, was quoted in order to destroy the English trade. Swedish wire was eventually prohibited from being sold in England by special enactment. At present Brass wire is sold as follows:—Brass wire used in making pins, £4 11*s*. per cwt.[*] Ordinary brass wire, £4 15*s*. 8*d*. Soldering brass wire, £5 9*s*. 8*d*. per cwt.

A considerable quantity of the brass wire made in Birmingham finds its way to the Gold Coast, to Old Calabar, in the form of what are called "guinea rods," one hundred of which, each three feet in length, of Nos. 4 and 5 gauge in thickness, packed up in deal cases, and being at their destination, sold in exchange for palm oil, &c., are used as the "circulating medium" by the natives, and at the death of the possessor are interred with the body. An influential Birmingham merchant states the orders from that country frequently amount to from five to twenty tons each. Large numbers of rings made of solid brass wire, about seven-sixteenths thick and three-and-a-quarter inches diameter, made of wire, are also sent to the Gold Coast. A smaller size of brass wire (a little thicker than ordinary pin wire) is converted by being wound round spits into spirals like an ordinary check bell spring, and is also exported to the locality named for purposes of ornament and personal decoration. To the west coast of Africa the wire is sent in rods or straight lengths, and to the east cast in rings or coils, where its purchase is monopolised by the Banyan or Arab merchants immediately on its importation—Zanzibar being the chief depôt. Wire of the No. 4 and 5 gauge is generally preferred. When sent into the interior, the large 50 lb. coils are sold at prices varying from 50*s*. to 67*s*., and are divided into three or four rings called, "khata," for convenience of carriage, and attachment to the "banghy" or carrying pole. Native artisans at Unyanyembe convert the wire into the coil bracelets, a "khata," or ring of wire being sufficient to form two or three of these ornaments, each of which weighs about 3 lbs. The "katinda," or coil bracelet is sold, when made, for one dollar (4*s*. 2*d*.) each. The katinda bracelets were formerly made of copper wire, but its cost has been the means of introducing brass wire instead. Though the east African can draw *fine* brass wire, they import it from Zanzibar into the interior. The gauges preferred are from No. 22 to 25; this they convert into a variety of ornaments.

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[*] 15,000,000 pins are said to be daily called for in this country, in the manufacture of which 2,727 lbs. of brass wire is consumed. Some idea of the consumption of brass wire in the manufacture of pins may be gathered from the fact, that one firm in Birmingham consumes 150 tons per annum, or 336,000 lbs.

The very general use of brass wire as ornaments among the tribes of Africa is well illustrated as follows, from the pages of Burton's travels in Africa :—

> "The costume in brass, worn by the Wanyamwezi, are brass 'bangles,' or massive brass rings, frequently weighing 4½lbs each, on the wrists. The forearm bears 'katinda' or coil bracelets ; the waist is girt by a coil of wire twisted round a rope or fibre ; and the ankles are covered with a profusion of iron bells, thin rings of brass and copper wire."
>
> "The wives of the chiefs of the Wabwari wear a lot of brass ornaments."
>
> "The ornaments of the Wusagara, in addition to beads, are the 'katinda' (their weight is the test of wealth and respectability), extending from elbow to wrist. Others wear little chains or thick 'bangles' of copper, brass, and zinc ; and those of more ample means twist a few circles of brass under the knee in addition."
>
> "The sultan of Insene eschews and despises beads, preferring coils of copper or brass wire."
>
> "Even the porters, of which great numbers are attached to each caravan on its journey to and from the interior, in addition to massive ivory bracelets, wore heavy 'bangles' of brass or copper, and thin circles or discs of the same metals."

Livingstone, in his travels to the Zambesi, still further illustrates the use of brass wire, and brass in Africa, by describing a Makololo woman attired not in a costume supplied by a Parisian "modiste," but in that of Dame Nature, aided by a Birmingham brass wire manufacturer. He says :—

> "Sebituane's sister, the head lady of Sesheke, wore eighteen solid brass rings, as thick as one's finger, on each leg, and three of copper under each knee ; nineteen brass rings on her left arm, and eight of brass and copper on her right ; also a large ivory ring above each elbow. She had a pretty bead necklace, and a bead sash encircled her waist. The weight of the bright brass rings round her legs impeded her walking, and chafed her ankles ; but, as it was the fashion, she did not mind the inconvenience, and guarded against the pain by putting soft rag round the lower rings."

In addition to rings of brass wire, or of cast brass, very large quantities of Armlet and Anklet rings, made of tube, and varying in size from 2¾ up to 3½ and 4 inches internal diameter, are made in Birmingham, and sent out to Africa. These weigh from 2½ oz. up to 4 oz. each, are similar to cornice rings, but have no loop. Neither are they united at the junction with solder, in order to admit of their being opened the more readily, to allow of their being placed on the arm and leg of the wearer. These rings are ornamented by "milling tools," finished by burnishing and lacquering, and are used by merchants on the Gold Coast for payments of debts and exchanges with the natives, who bring down palm oil and other natural products, receiving the rings in barter. These rings form the decorations of the natives, their number indicating the wealth and position of the wearer. Some idea will be gathered of the extent of Birmingham orders for this commodity from the fact that some three years ago one order executed in this town extended to 20,000 dozen, or 240,000 rings, 3½-in. diameter, the weight of brass consumed in their manufacture amounting to nearly 23½ tons.

6.—BRASS AND COPPER TUBE MANUFACTURE, SOLDERED, SOLID, AND ORNAMENTAL.

There is an immense consumption of brass in the form of tubes in Birmingham manufactures, inferior only to that in the manufacture of locomotive and marine engine boilers. This important branch of the brass trade we now propose to consider. No doubt all tubes were formerly hand-made, and produced by cutting a strip or ribbon from a sheet of rolled metal, turning up the strip over an iron rod of the size of the interior of the tube required, binding the edges of the partially formed tube together with rings of wire, placing solder and borax along the seam or joint, and fusing the solder by means of an ordinary forge fire; then, after removing the wire and surplus solder, the crude tube was hammered round on the iron rod over which it had been bent up. Tubes so produced were necessarily imperfect, unequal in diameter, and unfitted thereby for purposes where accuracy was required. The inventor of the draw bench is not known; but Sir Edward Thomason certainly introduced some important improvements therein, which, no doubt, operated very materially in developing the brass tube trade.

The manufacture of ordinary soldered tube is now practised as follows:—From sheets or rolls of metal, strips are cut of the requisite breadth by means of revolving or circular shears propelled by machinery. If these strips are of strong metal, or for large tubes, they are rendered concave in their entire length, by passing through rolls, one of which is concave, the other convex. The end of the strip is converted into a tange by two blows with a hammer. The drawing tool being placed *in situ* on the draw bench, the tange is passed through it. It is then connected with the draw-tongs attached to to the chain, which are moved along the horizontal surface of the draw bench. The wheels and pinions which drag the chain along are placed "in gear;" the tongs compressing the tange of the strip of metal, are dragged along, and with them the strip of metal, which in its passage through the tool is converted into a cylinder, with a seam down its entire length. In this condition the partially formed tube is passed to the "wirer"—usually a girl—who binds the edges together with iron wire at intervals of two inches apart. It is then passed to the "charger," who places along the seam a granulated brass solder, mixed to the consistency of clay with borax. In this condition the tube is handed to the "solderer," who passes the tube into a soldering stove; it becomes gradually heated to a red heat, when the solder melts, and unites the two edges together; the tube is now a perfect one. On cooling, the wires are untwisted and taken off, the surplus solder removed by filing, the tube immersed in oil of vitriol pickle, then washed out in water. The concluding operation consists in passing the tube again through the tool in the draw bench. If an ordinary tube, it is considered as finished; if mandrill-drawn as for pump cylinders, telescopes, or for purposes where great accuracy is required, a steel rod or mandrill is placed or passed in or down the interior of the tube, and in this position it is drawn through the tool, which compresses the brass tube on its internal steel support, and produces, on the withdrawal of the mandrill, a tube parallel in its internal and external surface.

Admitting the difficulty of pointing out when tube making was introduced into this town, or the inventor who first created appliances which facilitated its production by power, that wire drawing suggested tube drawing appears a self-evident result. Draw benches were familiarly spoken of in 1782; they had, therefore, been in use long prior to that year; but while the period of the introduction of brass tube making cannot be determined, that of one of its most important branches can; the invention and inventor of patent or cased tube being clearly defined. In the "Memoirs of Half a Century," by Sir Edward Thomason, he modestly tells us, "During the year 1803, I put up a complete machine for drawing tubes in a new and peculiar way. The radius of the winch connected with and governing a series of wheels gave the machine great power." "This mode of drawing tubes led to much novelty of invention, and eventually to that of sliding hearth brushes. In watching the operation of drawing brass and copper tubes upon the mandrill, I found it required as much power to slide off the hollow tube from the mandrill as was required to draw it on. Reasoning from the adhesion of the brass tube to the steel mandrill, I found by experiment that the union of copper and iron, or brass and iron, could be firmly attached by pressure, and conceived that such an application would be useful for making of copper bolts for shipping, solid brass rods for stair carpets, solid brass to go round the top of a room, to suspend pictures, as curtain rods for drawing rooms, and as balustrades for stair-cases." "This mode of manufacture led to the brass bars or railing at the front of the London shop windows. It gave strength and the appearance of solidity, when, at the same time, the whole was only of sheet iron, except the thin casing of brass drawn over it by pressure." Thomason, at an early period, fitted-up "many splendid stair-cases," among others, for the Queen of Wurtemburg, the Marquis of Westmeath, Lord Forester, and that of the Plough Hotel, at Cheltenham. Some eight years after, in 1811, Benjamin Cook, (who was one of the earliest makers of metallic bedsteads, &c.,) obtained a patent for combining and connecting together different kinds of metals, and also metals and wood, in such a way as to make combinations thereof. The former was essentially Thomason's invention; the latter was original, and is familiarly known as the process by which wood brass covered poles were, and are now produced. Thomason had no difficulty in proving the right of "user, as he had sold articles made similar to those patented" years before Cook had thought of the method. The difficulty was, however, got over by Thomason getting a letter of license to sell whatever he chose during the term of the patent. Thomason, therefore, (and not Cook, as has been generally understood,) is entitled to be considered the inventor of the now familiarly known patent, or iron brass-cased tube, and also of solid iron stair rods cased with brass. The quantity of patent tube now made and consumed in the manufacture of picture rods, bedsteads, railings, and hollow stair rods is almost incredible. One leading firm engaged in the manufacture states that its production of the Patent Tube exceeds 100,000 feet per annum. The process of patent tube making has not been improved in any particular since the days of Thomason, saving that recently, instead of cutting the iron from charcoal sheet, Mr. Thomas Potts has substituted hoop iron of proper widths for the cut strip; the consequence is a slight reduction in price. The *modus operandi* of manufacture practised in the making of patent tube is simple. The centre cylinder or tube of iron is drawn, as already described in the operation of brass tube making.

The brass or outer case is made in a similar manner, and soldered, but made so much larger that it slides easily over the iron tube it envelopes—over which it is slipped—the two tubes being permanently united together by being drawn through a tool, and the brass case being compressed on the iron interior tube an iron tube, with an exterior brass covering, is the result. When patent tube is intended for bending, it is customary to solder the seam of the interior or iron tube also. For ordinary purposes, or when the tube is used in straight lengths, as picture rods, &c., it is unnecessary to do so.

Attention will now be directed to the manufacture of a class of tubes, which cannot be produced by the ordinary processes in use in the tube trade. It may, here, however, be incidentally remarked that, so long as the tube is parallel, its ornamentation, so far as regards external longitudinal decoration, can be accomplished by the ordinary drawbench and tool, thus :—A round, square, diamond, triangular, octagonal, sexagonal, convex, or concave reeded tube, is simply produced by substituting a form of tool, the internal surface of which is shaped in accordance with the external surface of the tube which it is intended to draw. Taper tubes, on the contrary, require a special provision for their manufacture, and the invention of tools for their production has attracted the attention of not a few ingenious minds. It will be readily understood that in order to draw a taper tube, an expanding tool is required, in order to adapt itself to the gradually increasing diameter of the taper to be drawn. Some clever combinations of springs operating on segments of steel, intended to produce taper tubes of various forms in external diameter, have been produced from time to time, but such may be classed among the mechanical failures of the past. In 1813, Mr. Henry Osborn succeeded in producing tapering cylinders by means of a pair of rolls, with tapering grooves cut in their external surface. The same process was claimed as an invention by Dr. Church and Mr. Jonathan Harlow in 1841. Taper tubes, however, of diameter corresponding only to the groove in the rolls could be produced, and any variation necessitated sinking or cutting new rolls specially. The most ingenious and universally applicable process for producing tubes of varying tapers, whether reeded, fluted, twisted, or many-sided in their external form, was that invented by Mr. John Ward, now of the Birmingham Tube Works, Digbeth, in the year 1848, who introduced, instead of rolls, an expanding tool formed of block tin. The process being as follows :—The soldered-up taper cylinder or tube is slipped on to a steel or iron mandrill of the form corresponding to the desired tube; in this condition the end of the mandrill and tube is caught by the tongs of the drawbench, and is pulled through the soft metal tool, which reluctantly expands, but still clings to and compresses the sheet metal case into the form of the mandrill by which it is internally supported. The beautiful simplicity of this application is not its least recommendation; the tool is economical in cost of production, as the metal of which it is cast can be re-melted and re-cast into tools after it is used; economy and variety are thus united together. By no other process in use in the tube trade could the same amount of structural ornamentation be given at the minimum of expenditure.

In the production of twisted tube, the tool which imparts the twist, or spiral, is simply a revolving nut, held firmly in a suitable frame. When set in motion it acts as a screw plate, and threads the tube in its passage through. Diapered or diamond-pattern tube is produced by a similar tool and in a similar manner, only it is twice passed through—first, through a right-hand threaded tool, and second, through a left-hand threaded tool. Considerable quantities of this variety of tube are consumed in the construction of mediæval brassfoundry, gas fittings, &c.

An ornamental variety of brass tube was introduced in 1852, consequent on the invention of the ornamentation of metal by pressure* by the late Mr. Richard Ford Sturges.

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* The reader may be reminded that this process in all probability was that which gave rise to the art of Nature-Printing, for which the Austrians take credit, and for which the late Mr. Henry Bradbury received an amount of praise by no means deserved. It remains to be proved where the Austrians got their idea; but it is certain that Mr. H. B. got his from the Austrian Printing Office, in which he was employed at Vienna. Dr. Branston, then of Sheffield, in 1849, printed with casts taken by gutta percha from natural objects in the year 1849, having, however, first taken a cast from some in brass. In 1852, the writer of this, in experimenting on the ornamentation of metal by pressure, used natural objects, as feathers, leaves, &c. It occurred to him that he had procured an impression in metal which could be printed from. He therefore at once took the metal plates (formed of Britannia metal) to a copper-plate printer, Mr. Martin Billing—had them inked and printed from. The result was a perfect impression of the object used, *i.e.*, a feather, even to the down which surrounds the quill. The writer of this read a paper before the London Society of Arts, February 15th, 1854, in which he challenged alike the Austrian patent and the claims of Mr. Bradbury. Mr. Bradbury was present at the meeting, but remained silent. Mr. Bradbury and the Austrians arrived at their conclusion by a roundabout process of taking an impression on lead, and from the lead a copy by electro deposition, and a second plate by deposition, which formed that printed from; but the writer used Britannia metal, which is harder than lead, and printed from it direct, thereby securing details which are lost in taking two electro deposition plates. By using Mons. Joubert's acieraging, or steel deposit process, the Britannia metal plate is rendered equal in endurance to a steel plate. As it is, 500 impressions of feathers and leaves have been taken from one Britannia metal plate. The writer has still the plates in his possession. It is worthy of remark that the Austrian patent for copying *lace* was taken out between May and October, 1852, but Mr. Sturges had printed from *lace* in August, 1851. A Mr. W. Taylor, of Nottingham, exhibited in the Exhibition of 1851 examples of *lace and tambour* work printed in some way from impressions taken from the objects represented. Sturges' patent for ornamenting metals by pressure from *lace, wire work, and paper*

This ornamentation was effected, by placing between two sheets of metal, perforated paper, thread lace, or perforated zinc. On passing the metal through the rolls, the pattern of the paper, zinc, or lace, was indented in the brass; the brass so ornamented was made up into tube, of which considerable quantities were sold.

By far the most successful system devised for the ornamentation of brass tube was that provisionally protected and patented by Mr. Fearn, of Vittoria Street, Birmingham, in 1852, by which the tube, after being made, was ornamented by means of plain rollers arranged in a frame to form a tool similar to that used in the production of the solid seamless brass tubes—hereafter to be described—with this difference that on the outer concave surface of the groove of the rollers was cut the design or portion of the design which it was intended to indent on the surface of the tube to be ornamented. The plain tube, with an internal support or mandrill of steel, was introduced into the tool and drawn through; the rollers revolved, and in their revolution impressed the design on the external surface of the plain tube presented for ornamentation. The limit of this style of tube decoration is only bounded by the power of the designer and the skill of the die sinker. The patent was allowed to lapse at the end of the third year; it then became public property, and as such, from the ornamentation of pencil cases and small tubes, it has been applied extensively for the general decoration of all sizes of brass tubes to be converted into gas fittings, bedstead pillars, and articles of cabinet brassfoundry, fire and window guards, &c., and, so applied, adds very greatly to the attractive features of the objects of which it forms a part. It is to be regretted that in the hands of the inventor the process failed to realise its true measure of usefulness and profit.

With the introduction of phosphorus or metal magnanese into the alloy of copper and zinc of which tubes are made—

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was sealed on the 24th January, 1852. Of course the specification was immediately printed, and the details open to investigation. Where, then, are the claims of Austria—of Mr. H. Bradbury? *Lace* is not a natural production. Natural objects were soon copied, but the writer believes that the Austrian claim is worthless, and that the first natural objects were printed from in Birmingham; but while admiring works produced by a National Treasury, as in Austria, and those produced by Mr. H. Bradbury, he declines to recognise a claim for originality where it is not due, and unsupported by better evidence than has yet been adduced. There is, however, a certain Peter Kyhl, a Danish goldsmith, who appears to have done something in Nature-Printing, in the way of copying natural objects, so far back as 1833. His work is stated to be in MS., and reposes in dust in the archives of a museum in Copenhagen. He also appears to have ornamented silver wares; this information, though stated, has not been proved, and must be taken for what it is worth. The writer adheres to his opinion that Nature-Printing owes its recent successful progress to Birmingham.

a plan said to improve the purity of the metal, its cohesive properties, and its solidity, and which is due to the result of the investigations of Messrs. Alexander and Henry Parkes, the *chief* features of the improvements and advances in the manufacture of tube, more particularly brass and copper, have been alluded to; if we except certain preliminary processes, as the casting of the billets and appliances by which it is intended to render the billets more solid in texture, or the formation of billets by forcing these by pressure out of flat discs of sheet metal. As these are matters of detail only, and do not materially affect the increase or facilitate the production of such tubes, they may be passed over without additional comment.

SOLID OR SEAMLESS BRASS TUBES FOR LOCOMOTIVE OR MARINE ENGINE BOILERS.

Brass tube making appears to have had no improvements introduced into its mode of manufacture of any importance until the year 1838, previous to which year it was produced as already described, *i.e.* the tubes had seams along their entire length, which were united by soldering. Tubes of lead or block tin had been produced seamless, the former by hydraulic pressure, the latter by drawing down (through a succession of tools diminishing in internal diameter till the size desired was reached) a thick cast cylinder of tin, the interior of which was filled with a "spit" or "mandrill" of the internal diameter of the tube required, which was afterwards withdrawn. The necessities of modern travel, however, had rendered the production of brass tubes wherewith to fill the boilers of Locomotive and Marine engines of the utmost importance, as the steam was more easily evolved by their introduction. Iron tubes are corroded by the water from which the vapour is generated, hence the necessity for substituting another metal not liable to rust or oxydation. The soldered joints of the tubes made of copper or brass not unfrequently showed weakness, or leaked, owing to imperfect soldering, and the production of seamless or solid brass tubes, as they are now called, became a desideratum, which was supplied in June, 1838, by Mr. Charles Green, who, by aid of machinery proportionably more powerful and in unison with the more unyielding material to be drawn, converted thick and short cylinders of brass into elongated tubes suitable for the purpose intended. The drawing tool in Green's method is not, as in ordinary tube making, a hole punched out from a bar of steel, but is formed by four steel rollers, the concave surfaces of which, when united together *in situ*, formed a circular tool, which in concavity corresponded to the external diameter of the tube to be produced; the reducing, or drawing down process, being facilitated by repeated annealings of the tube in progress of manufacture. This method of tube making was accepted as satisfactory by engineers; the consequence was an increased and increasing demand for brass tubes for the purposes named. The progress of solid tube making was not, however, destined to remain stationary. In May, 1852, Mr. George Frederick Muntz, jun., patented, along with an alloy of 60 per cent. copper and 38 parts of zinc for making seamless tubes, a new and ingenious method of making such tubes. His billets were cast oval, not cylindrical; they were rolled out or elongated when the metal was at a red heat, and the cylindrical form was given in the last operation. The history of solid tube making would be incomplete as regards brass and copper were no allusion made to the patent taken out in 1850 by the late Mr. Thomas Attwood for the production of seamless copper tubes from the worn-out rollers of calico printers, when abandoned by them as useless. The rib or slot, which held the roller on its axis, being removed, the copper billet, as it may be called, (*i.e.*, worn-out roller,) is rolled, or drawn down to the diameter required.

Some idea as to the immense demand for brass solid and copper tube—more particularly the former—will be arrived at if it is considered that, by the last computation of railway statistics which is complete, that of 1864, it is shown that in England there are in working order 8,890 miles of railroad; in Scotland, 2,105 miles; in Ireland, 1,794. In England, the proportion of locomotives is 64 to every hundred miles; in Scotland, 55; in Ireland, 27; giving a total of 7,337 locomotives in use in the railways of the United Kingdom. On competent authority it is said that two-thirds, or sixty-six and two-thirds per cent. of the number of locomotives named, are fitted up with solid seamless brass tubes; this gives 4,893 engines. As the average number of tubes in each locomotive boiler may be taken at 150, and each tube is at least twenty-five pounds weight, the total weight of brass tube in the service of the various railway companies cannot be less, at the present time, than 8,500 tons. Marine boilers also require seamless brass tubes, the diameters of which are larger, *i.e.*, from two-and-a-half to three-and-a-quarter inches each tube, from six feet to eight feet in length, and weigh from fifteen up to thirty pounds. A set of boilers for one steam ship requires from two to three thousand tubes, the weight of such tubes amounting to about twenty-five tons. Taking 2,500 tubes of 22½ lbs. each as an average number and weight, admitting that the marine tubes in use amounted to half the quantity of the locomotives, gives the weight of solid brass tube in use for locomotive and steam-boat purposes in England, as equal to nearly 13,000 tons; and at eighty-five per cent., about 18,300 tons.* These tubes, it is understood, are replaced once in three years; and as the number of locomotives is increasing, as also steam ships for the navy and for the merchant marine service, this suggests that the solid brass tube trade is destined to be an increasing and permanent manufacture. Boiler tubes, in brass, are replaced at an average every three years. A competent authority consulted states that the quantity produced by the six Birmingham houses in the trade is 4,500 tons for locomotives, and 2,000 tons for marine engines, or 6,500 tons annually. In the manufacture, 5,000 tons of best-selected copper is consumed, and 1,700 tons of spelter; the wages paid, about £27,000 per annum. Locomotive tubes are also made by Newton, Keates, and Co., Liverpool, and the Broughton Copper Company, of Manchester. Some few are also made in Newcastle.

The contracts issued by the London and North-Western Railway Company, for tubes alone, amount to 300 tons annually. As the estimates referring to the brass tubes in use on the railways of the United Kingdom may be considered problematical, another example is given on authority which can be vouched for.—On the railway which traverses the East Indies, extending from Calcutta to Delhi, a distance of 1,100 miles, there are now working 310 locomotive engines, containing from 150 to 170 tubes in each boiler. Assuming 160 tubes as an average number, and the weight of the solid brass tubes at twenty-one pounds each, the total weight of the tubes at work on that railway *alone* would amount to 465 tons, 9,300 hundredweights, or 1,041,600 lbs. As however, 120 engines in addition are being built, 180 tons will be added thereto, which will give a total of 645 tons of solid brass tubes in use on this railway, so important to the trade and commerce of Central India, which has reduced a journey which occupied three months into the short space of two-and-a-half days!

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* The writer being anxious not to overstate the percentage of engines in which brass tubes were used, an enquiry was made of an eminent engineer, who replied as follows—"The brass tubes in locomotives in England, I think, are about eighty-five per cent. of the whole quantity of tubes used; a friend familiar with locomotives thinks the same. The mercantile marine use some iron tubes, probably over fifty per cent. of the whole; but then the Government use decidedly less iron tubes. I should say off-hand they use seventy per cent. of Brass, and I am not sure whether they have not decided to use all brass."

It is interesting to know that the first introduction of tubes into steam-engine boilers, as a means of increasing the heating surface, and more speedily "getting up the steam"—now so very generally and universally adopted in the boilers of locomotive engines, &c., the production of which tubes has operated so beneficially on the solid brass tube trade of the town—may be said to be due, and is shown by Mr. Smiles in his recent admirable "Lives of Boulton and Watt," to have originated with the former. In connection with experiments on the best forms to be adopted in the boilers for engines then being made at the Soho, he found, by experiment, the water more speedily converted into steam by the introduction of tubes through the entire length of the boiler. In 1780 he wrote to Watt, then resident in Cornwall, on the subject, suggesting the application of tubes in boilers, and that the tubes should be made of iron. To the material Watt objected, but the application of tubes for the purpose intended he did not oppose. Boulton then suggested tubes of copper, to which his partner assented. He then carried out his suggestion by introducing four copper tubes, 20 inches in diameter, and 26 feet long, into the boilers of the Wheal Busy Mine engine, the fire passing through two of these and returning through the other two. He thus anticipated the present form of many-tubed boilers. It is no mean tribute to the genius of Boulton that the requirements of modern locomotion and navigation should have recognised in the tubular boiler that which is best fitted to give life, vitality, and motion to the locomotives, and which drag their freight of human beings, &c., over the network of railways extending to 12,700 miles in the United Kingdom alone, and also into the boilers of the steam ships which plough the surface of every ocean. Trevithick, in 1815, meditated the introduction of tubes to locomotive boilers, and he introduced them perpendicularly. Gurney, Summers, and Ogle, worked in the direction of the application of steam locomotion on common roads, and used tubes also in connection with their boilers. It was reserved for George Stephenson to realise in the old "Rocket" Engine, produced in 1829, the form of tubular boiler, as now used, with slight modifications, in locomotives. In the engine named he introduced twenty-five copper tubes, each three inches in diameter; the fastening-in of these tubes is an amusing incident in the life of his son Robert.

These tubes were fitted into the boiler with brass flanges and nuts; leakage resulted. The son wrote to the father in great grief and tribulation; he replied, "bore out clean holes in the boiler ends; fit in the copper tubes as tightly as possible; solder up, and then raise the steam." The plan succeeded perfectly, the expansion of the copper tubes completely filling up all interstices. No solder is used now, but the end of the tube is simply turned over with a suitably formed punch or drift. Copper tubes were eventually changed into brass. To Matthew Boulton and George Stephenson, therefore, the tube manufacturers of Birmingham owe their solid locomotive and brass tube trade.

The production of brass and copper tube in Birmingham may be estimated at not less than from 8,000 to 9,000 tons per annum, of which between 6,000 and 7,000 tons are solid or seamless, and the remainder is made by the ordinary process of drawing from flat strips of metal, and soldering up the joints.

In the manufacture of the seamless tube the labour of adults is more generally employed than in tube making of the ordinary kind. The average wages of the workman may be stated as 30*s*. per week; labourers who attend to the annealing and pickling of the tube in process of manufacture receive from 15*s*. to 18*s*. per week. In the soldered tube trade, as the processes are more numerous, there is a greater scope for the employment of female and juvenile labour; not unfrequently a foreman undertakes to produce the tube at a certain rate per cwt. or ton, in which case he pays the workpeople under him. Good workmen earn from 20*s*. to 30*s*. or 35*s*. per week; lads who assist in carrying the strips about and assisting generally, from 4*s*. 6*d*. to 10*s*., according to age and ability. Women employed as solderers are paid from 10*s*. to 12*s*. per week; and girls who wire, or bind the tubes with wire preparatory to their being soldered, and remove the wires after the soldering operation has been completed, earn from 4*s*. to 8*s*. per week. Payment, however, is dependent on the amount of skill and expedition displayed.

7.—LAMP MAKING, LUSTRES, CHANDELIERS FOR OIL AND CANDLES, AND SMALL BRONZED ORNAMENTS.

Lamp, Lustre, and Chandelier manufacturers were, as will be readily understood, a very much more important body in the brass trade than they are at present. Formerly, tallow or wax candles and oil supplied the only sources of artificial light, these materials are now only exceptionally used; consequently, some thirty or forty years ago the trade of lamp making, &c., was a very much more important one than it is at present, or ever will be again in time to come. Gas has given the quietus to lamp making, if we except those for paraffin, and the chief manufacturers of lamps have been absorbed into the manufacture of Gas Fittings. But the trade is one which has claims to consideration, in so far as while the mechanical construction of the oil lamp employed and kept alive a superior class of workmen, it developed and encouraged the art of design and modelling, (imitative certainly,) in which portions of the remains of classic mouldings, copied from Stuart's Athens and Piranesi, were used, and in which the pillars Corinthian, Ionic, Composite, &c., in character, supported lamps, or Caryatide figures bent under the imaginary weight of the lamp head they were supposed to sustain. One design represented "Atlas supporting an improved brass Liverpool lamp," with arms extended, hands pressed on stomach, the lamp apparently balanced on his head, conveyed the unpleasant impression that the head of the lamp would speedily roll off. Hanging lamps were of equally strange design. Imitations of the Warwick Vase formed the receptacle for the oil; the arms to which were attached the burners concealed below by heavy cast "boats," or bodies; bearded philosophers or ivy-crowned satyr masks grinned down on the possessor of the lamp who stood below, and honeysuckles, vine leaves, fruit, &c., made up the component parts of an incongruous whole. These articles were then accepted in the days when art and taste was the exception rather than the rule, as examples of supereminent art applied to industry. Probably nothing more instructive as to progress in the direction of applied design can possibly be gathered, than by turning over the pages of the pattern books of the Messengers and Timothy Smiths of a by-gone period. We learn therein the traditions on which ornament was founded, and following these traditions, we see how much originality was sacrificed on the altar of antiquity, fitness never for one moment being taken into consideration; and hence, the misapplication of forms, abstractly good in themselves, imperfectly reproduced for purposes for which they were totally inapplicable. Nor at this period were these reproduced by inferior artists or modellers. Flaxman, whose graceful, elegant, and poetic fancy illustrated so beautifully passages in Homer and Dante, whose sculpture charms from its chaste and pure, yet simple dignity, modelled for the Messengers, as did also Francis Chantrey; and Wyon, a progenitor of the now-distinguished mint medallist, when in connection with the Soho, lent his artistic powers to the designing of decorations for the lamp work produced in that establishment, in addition to his avocation as a medallist. The various drawing masters in the town were also pressed into the service as "designers." The imperfect understanding which prevailed as to construction, or rather "that ornament should be designed without reference to construction," does not appear to have been understood at the period, or if understood, was ignored; still, however, these gropings in the dark are entitled to respect, as the harbingers of a better time coming which has now arrived, or to which we are rapidly approximating.

In the introduction we have referred to the construction of lamps. In the older and more primitive examples, the wick was then a solid one, which communicated with the oil directly, and combustion took place only at the point where the atmospheric air was in contact with the flame. In the hands of the ancient Greek and Etruscan metal workers, the vessel which contained the oil assumed very elegant forms; but the principle of the lamp produced was crude to a degree, and differed not one whit from that adopted by savage nations, wherein the wick is simply placed in a crude earthenware or metal vessel. The wick was drawn up when consumed, by pins or other rude contrivances. Of lamps made on this principle, great quantities were produced in Birmingham previous to the year 1780, though slightly modified in external form, and by no means so elegant as their classical prototypes. In the year 1789 a great change took place by Mons. Argand inventing an arrangement consisting of a circular wick and a passage for air up the centre of the flame. By this arrangement the flame was surrounded by two concentric currents of air by the addition of a chimney, at first made of iron, but eventually of glass. This chimney, supported on a holder outside the burner, imparted steadiness to the flame, the air being introduced between the outside of the flame through apertures of the glass holder and up the interior of the circular wick; the combustion was therefore more equal and rapid. (The form of the Argand burner for oil was at an early period adopted as the model for gas burners.) The introduction of Argand's improvement in lamps into those of Birmingham manufacture is due to James Watt, the great improver of the steam engine; who in correspondence with Argand, while learning all the French inventor had accomplished, made various ingenious suggestions on the subject of improved reading lamps, which, when produced, (according to his biographer, Patrick Muirhead,) "gave a light, surpassing both in steadiness of flame and brilliancy anything of the kind that had appeared in those comparatively dark ages." It is more than probable the suggestion of the glass chimney, and its change of form from that of a cylinder of equal diameter throughout to one which is contracted above the flame, is due to James Watt. The chimneys of the lamps first produced by Mons. Argand were formed of sheet iron. Among the multifarious manufactures which issued from the Soho Manufactory, lamps of various kinds were included, and formed no unimportant part of its productions. In Argand's lamps the wick was raised by means of a spiral thread cut in a tube, the wick holder, with wick attached, being operated upon by a longitudinal slit tube—the wick holder internal pin rising on the spiral thread by means of another pin attached also to the wick holder, but outside, which worked up the slit of the tube already alluded to. The slit tube was connected to the glass holder, on turning which the wick rose in order to allow of its being trimmed. From the year 1800 to 1820, great quantities of what were called "Liverpool" lamps were made. These were on the Argand principle, but a button or disc was introduced, which rose from the centre of the tube up which the air passed, and by impinging on the flame caused it to expand. In order to accommodate the direction of the flame, the chimneys were globular at the bottom, and terminated in a cylindrical form at the top. These chimneys were held on by means of two pins and a screw or thumb bit. Immense quantities of *Astral Lamps* (called French) were also made, in which the magazine or receptacle for the oil was a circular rim, so formed that but little shadow was cast by the burner, which stood in the centre of the circular rim, and was supplied with oil by two tubes connected with the burner and the rim, which contained the oil. These lamp heads were fitted to pillars or stands, the design of which has been alluded to in the introductory remarks. *Lamps for burning Tallow* were at one time made extensively in Birmingham, and numberless burners for the combustion of Naphtha, and lamps for the same purpose, were also produced. The disagreeable odour of the coal tar from which the naphtha was made, however, speedily operated in terminating the manufacture of these lamps, and naphtha, as a means of illumination, is now confined to lighting up booths and caravans at country fairs. Occasionally the lamp trade, after the introduction of gas, showed signs of revival, as on the introduction of *Palmer's Candle Lamp.* This variety of lamp, it is almost unnecessary to state, consisted of a tube to hold a candle or candles of various diameters, with a spiral spring in a tube, or barrel, which forced the candle as it was consumed up against the under surface of the cone-formed cap. These were made in all styles of ornament, from the most elaborate down to the simplest form of a tube to contain the candle, and a bottom on which to fasten the tube, as in an ordinary candlestick. China and glass highly decorated pillars were occasionally introduced in some of the more expensive varieties. The light of the candle lamps formed, however, a very inferior substitute for gas, and they are now very seldom sold, but representations of them are still found in the pattern books of lamp makers. Then followed the era of Camphine, which operated materially on the lamp trade of the time. As a means of illumination, when the spirit is pure, it is not inferior to gas; but the proper supply of air, in order to secure complete combustion, can only be arrived at by the nicest experiment. If due adjustment of the quantity of air is not attended to in the construction of the burner, then follows the escape of an unconsumed carbon in the form of flakes of a black snow, which was facetiously termed by *Punch* "an invasion of the blacks." The same distinguished authority compared the light and smoke of the lamp named to that of "a couple of farthing candles, and the smoke of six kitchen chimneys." Carefully attended to, all conditions being equal, the light was brilliant and colourless. The objections alluded to, the care required, imperfectly purified camphine, and an explosion or two arising from carelessness, in the course of a few years speedily terminated the demand for camphine lamps.

Moderator lamps were introduced from the Continent about the year 1850, and a few manufacturers in Birmingham directed their attention to their production. It may, however, be questioned if their manufacture ever was successfully naturalised in this town; the movements of the lamps, or their internal fittings, were alone made. The ornamental cases, many of which were very elegant, were imported from France; the demand there for this class of lamp, being very great, induced the French manufacturers to sink an immense variety of dies for the purpose of producing these cases or external ornamental coverings. The stands also, being chiefly made of zinc and cast in metal moulds, afterwards skilfully bronzed or gilt, were also produced by and purchased from the French manufacturers of moderator lamps. At present the demand for these lamps in this country has so declined that it is doubtful whether any manufacturer in Birmingham is engaged in what may be called their "manufacture" in the true meaning of the term.

How science affects and adds to the prosperity of manufactures is well exemplified in the recent demand for immense quantities of lamps and burners for the combustion of "paraffin" oil. Liebig, so far back as the year 1841, demonstrated by experiment that paraffin is merely the solid and liquid form of "olefiant gas," which is obtained from the distillation of coal and peat. This idea having been started, Mr. James Young, then of Manchester, observing that the oil from which paraffin is procured, being connected with the coal formation, might be produced from coal by distillation, his experiments were confirmatory. In the Exhibition of 1851, paraffin in a solid form was represented by a solitary example in *one* paraffin candle, in the exhibition of 1862 a solid block of paraffin was shown, which weighed upwards of half a ton, and its purity was demonstrated by its colourless, inodorous, tasteless, and beautifully translucent appearance. It is, however, in the condition of oil that we have chiefly to view this product and its influence on metallic industry. The first use of the oil was as a "lubricant;" eventually, it took its place as an illuminating agent. The bituminous coal of Wemyss, Torbanehill, Boghead, Wigan, Newcastle, &c., on being distilled at a low red heat produce large quantities of the oil named. In the year 1860, the manufacture of paraffin oil in this country had reached the quantity of 2,300,000 gallons. If to this is added the influence of the discovery within the last four or five years of the "hydro-carbon" oil springs of America and Canada,* also used for lubricating and illuminating purposes, we shall arrive at some idea of the demand for lamps to burn paraffin oil. With a properly regulated supply of air, these lamps produce a very much more brilliant light than can be obtained from the consumption of an equal quantity of whale, or vegetable oils. In 1860, a lamp manufacturer produced in one year 247,431 lamps for the consumption of oil manufactured by Mr. Young. In 1861, the same manufacturer was producing at the rate of 1,200 per day, or 375,000 per annum. At the first introduction of the paraffin oil, these lamps were produced by Scotch houses engaged in the brassfoundry trade; but in

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* The yield of petroleum in the United States of America, during the last five years, has been as follows:—1861, 24,000,000; 1862, 40,000,000; 1863, 70,000,000; 1864, 87,000,000; 1865, 91,000,000 gallons.

1861 the trade was introduced into Birmingham, and four lamp manufacturers began the manufacture. To these a new establishment was added, and small manufacturers turned their attention to the production of burners. The Birmingham production of paraffin burners reaches 500,000 annually; and of complete lamps of all prices, certainly not less than 75,000. Lamps were produced at prices varying from 7*d.* to 50*s.* each. Great quantities of "heads," viz., the receptacle for the oil fitted with burners, were manufactured. These receptacles were formed of flint, opal, and other coloured glasses. Bracket, reading, and pendant lamps, were also made. In these, the form of the bracket and pendant varieties (with the exception of the head) was adopted from the gas-fitting types. While, however, except from home competition, the manufacture of the complete lamp has been left comparatively untouched, the competition in the article of "burners" only (or that portion which screws into the oil receptacle) has been materially increased by importations from America and Germany. The English burners, which sold in 1862 at 8½*d.* each, are now reduced to little more than one-half; and quantities introduced from America have been offered at a still lower price. It may be questioned whether, in any branch of the brassfoundry manufacture, the division of labour and the facilitation of production, have been more attended to. The maximum in number within a given time, and the minimum in cost and profit, may be said to have been reached. As these burners are entirely produced from sheet brass, by the processes involved in Stamping and Piercing (already described), it will at once be understood that the rate of production is very rapid. A leading firm in the trade has stated that in the manufacture of these burners they use thirty-five pair of tools. If to the making we add that of the processes of dipping, lacquering, and fitting together; in all, thirty-eight operations, and three ounces of metal manipulated, a burner is produced for a mere trifle of cost. If the *modus operandi* for the production of these burners is important, attention to the proper quantity of air admitted is much more so, as on this depends the perfection of the burner, and the excellence, or the reverse, of the resulting light, the entire consumption of the carboniferous particles or their partial consumption only, and consequent attendant inconveniences of smoke, smut, and smell. For some years the paraffin lamp trade promises to be, if not an increasing, at least a steady one; and paraffin lamps will be adopted and take the place of those fed by animal or vegetable oils, in localities where gas has not been, or is not likely to be introduced.

The improvements of locomotion and the rapid increase of railways, and the regulations of the Admiralty as to the necessity for ships carrying lights, have had a great influence on the lamp manufacture. Of Signal Lamps for Stations, the lighting of the interior of Railway Carriages, and others for Marine purposes, great numbers of practically useful but prosaic-looking lamps and lanterns have been, and are constantly being, produced. The former and latter, when illuminated by their interior lamps, indicate by the white, red, blue, or green lenses exposed, signals of danger or safety, necessity for caution, or the existence of the object which carries the light. The manufacture of these is carried on by many of the establishments engaged formerly in the oil lamp manufacture, and one or two new establishments have been called into existence.

One special department of manufacture connected with and practised in common with lamp making by lamp manufacturers remains to be noticed, viz., the production of small articles, not in bronze, but bronzed, consisting of Inkstands, Vases, small Candlesticks, Girandoles, Pastile Burners, Paper Weights, Figures, Animals, and other objects smaller in size, with some pretensions to artistic design and execution, but often entirely deficient therein, and singularly so as contrasted with the same class of objects executed by French modellers and artisans—Barbédienne, Barbezat, Deniere, Miroy Brothers, and other French bronzists on their stalls at the International Exhibitions in 1851 and 1862. As a general rule, the class of works named produced by Birmingham manufacturers was inferior in every particular. They were badly modelled and badly chased. If a classic design was selected for imitation, it was utterly spoiled either in its adaptation to a purpose for which it was never intended, or the modeller deprived it of its beauty of line and elegant contour. Figures well modelled and selected for imitation were converted into grotesques (if the original was not cast from), and grotesque figures, if imitated when they had passed through the alembic of modeller, caster, chaser, &c., were simply malformations. The attempt was too ambitious, and the results could only be, or have been, tolerated by a generation which knew little of manufactures, and less of art. Can it therefore be wondered at that this branch of manufacture should almost have ceased to be cultivated in connection with the lamp manufacture? or that it should have passed away from among us to France, where the demand is greater, the modeller more intelligent and familiar with good examples of art workmanship—the chaser understanding the way to produce texture, and able to penetrate the intention of the modeller—the bronzer equally able to produce the colour which gives value to the united labours of all? Where good "bronzes" of a small size have been produced in Birmingham (such as Elkington's, which are entirely exceptional examples), they have not been due to their former producers, and there is every reason to suppose that even the perfection of these owes something to the influence of French artisans. A somewhat greater infusion of this element into English work cannot be objected to. "Art grows upon what it feeds upon." The ornamental metallic art of France, as regards its bronze working, is due to the munificence of its monarchs in encouraging the great workers in bronze from Italy to reside in France, and leave an impress which operates even now in bronze making in that country. Succeeding French sculptors carried on the production of large works in bronze, but, while they did so, they lent their influence on small works in the same metal; the result has been the present high position of the bronze manufacturers of France, which only by long years of patient perseverance Birmingham manufacturers may hope to rival. The stride made by French bronzists in the space which elapsed between the years 1851 and 1862 clearly indicates that the task will be a difficult one.

In one particular, viz., the production of imitation bronzes, figures, &c., the French retain a field untouched by any other nation. Allusion has already been made to moderator lamp stands produced in metal moulds, and then bronzed, by means of a superficial deposit of brass or copper, and then coloured to represent true bronze. They are thus produced from a carefully prepared original model. Metal moulds are made, which take to pieces like the plaster moulds used by the Italian plaster figure makers; into the metal mould, when closed, zinc in a melted state is poured, and speedily congeals. The cast produced is then trimmed up, bronzed, and sold at one-sixth of the cost if cast in bronze. Though deficient, so far as it lacks the finish of the "riffler" and "chaser," the bronze effect is admirably imitated, and figures imitative of, and copies of reductions from celebrated originals, are thus placed within the reach of those purchasers whose limited means would preclude the possibility of procuring examples in real bronze.

The wages of the artisans engaged in the lamp trade were comparatively high. In the best days of the trade, skilled workmen were well paid, and others in proportion. Female labour at an early period was not so common in manufactories as it now is; and, in the lamp trade, was confined to lacquering and wrapping-up. In the paraffin lamp burner trade, large numbers of press women and girls are employed to cut out, raise up, and perforate the several parts, which form a complete burner, out of sheet metal; and these are paid occasionally by the quantity, at other times by the week—girls realising from 5*s*. to 7*s*. 6*d*., and women, 10*s*. and 12*s*. per week.

8.—GAS FITTINGS' MANUFACTURE.

That Birmingham should now be the grand centre for the manufacture of gas fittings, whether plain or ornamented, is not to be wondered at, when considered in connection with its industry in metals—particularly brass—and as also that the first practical application of gas for lighting purposes was due to William Murdock, of Soho, the trusted servant and valued friend of his employers, Matthew Boulton and James Watt. In 1792, Murdock, then superintendent of the engines erected by the firm named, in Cornwall, lighted up his offices and house at Redruth with gas; and, in 1802, on the occasion of the peace demonstration of that year, the "new light" illuminated and disclosed in dazzling brilliancy the exterior of Soho House, at Handsworth, then the dwelling of Boulton, still standing, and the long extended front of the manufactory, now, alas! numbered only with the memories of the past! Murdock had, however, previously demonstrated the advantage of the new light by lighting up the offices at Soho; and in 1803, the whole manufactory was supplied regularly with gas. In 1804, the manufactory of Philips and Lee, at Manchester, was "lit" up, and very speedily Gott and Son, at Leeds, followed their example. Although the genius and scientific knowledge of Sir Humphrey Davy failed to comprehend the practicability and application of gas to the lighting of towns, in 1812, it was introduced into London, and in 1815, into Paris. The imagination of Walter Scott failed to realise the possibility of lighting up towns or dwellings with "smoke," as he facetiously called it, but in a few years he became a convert, and fitted up Abbotsford with gas. Absurd notions prevailed as to what gas was, and this no doubt greatly retarded its more speedy introduction. It was supposed to be in a constant state of ignition in the interior of the pipes; its pressure was exaggerated, and its explosive powers magnified. In order to provide for this, even so far down as the year 1819, Mr.

Wetherly Phipson, of the Dog Pool Mills, patented a gas pipe formed of lead internally and copper externally. Thirty years afterwards, *i.e.*, in 1849, a double brass tube was patented by Mr. R. W. Winfield for greater security, and intended to be applied to the manufacture of gas fittings. Mrs. Partington's futile attempt to sweep out the tide of the Atlantic Ocean with her mop, was not more successful than attempts to oppose the general introduction of gas, which soon rose in favour, and from the lighting of streets was introduced into shops, and thence into private dwellings. At an early period, the best gas fittings were made in Edinburgh; and about the year 1810, the late Mr. Messenger, of Broad Street, procured a workman from Edinburgh (the late Mr. Saunderson), and commenced the manufacture of gas fittings in Birmingham, and Mr. Heaton (an old and respected superintendent of the Birmingham Gas Company), informs us, that when at work in London in 1812, he fitted up gas work, made by Mr. Benjamin Cook, of Birmingham. To the two establishments of Messenger and Cook may therefore be traced the beginning of one of the now most important departments of the brass trade in the town.

If any of the earlier examples of these fittings exist, their bald forms would call up a smile, and their imperfect fitting seriously affect our sense of smell. All the keys or plugs of swivel joints and taps then used for gas were rivetted like the keys or plugs of ordinary beer and spirit taps (the era of screw and washer not having arrived). The forms of the various fittings were crude, imperfect, and ungainly, and the higher class of chandeliers or gaseliers—(a new word now superseding the absurd term *gas* chandeliers)—consisted in the making use of the series of patterns which had done duty for an oil arrangement, the lights occupying a similar position to the oil burner with its wick. The manufacturers and public failed to observe that, while contracted arms were a necessity of the oil order of things, consequent on the receptacle which held the oil being required near the burner, the requirements of gas did not necessitate this, while economy of light and its diffusion were increased by an extension of these arms or branches. If the then state of artistic excellence had been equal to the emergency, these might have been clothed (as they now are) with graceful ornament. That demand increases supply; and competition among manufacturers is a healthful stimulus and productive of improvement alike in design and manufacture, the gas fitting manufacture among others is an illustration. The period at which it became a distinct and separate department of the brass trade is not clearly known. In 1820, probably some few lamp makers made gas fittings. In 1833, five manufacturers of gas fittings appear in the directory. In 1847, they increased to seventeen. In 1865, they numbered twenty-five. With this extraordinary increase of producers there has been an extraordinarily increased demand for gas fittings. In every quarter of the globe where gas has been introduced, Birmingham manufacturers of gas fittings find a market; the substantial quality of their articles securing a preference, and being exported to various cities and towns in Russia, Austria, Prussia, Holland, Spain, Bavaria, Belgium, Brazil, Chili, Batavia, Java, China, Japan, and to the East and West Indies. With this extended field of operations abroad, and an increased and increasing home trade, the expansion and increase is readily accounted for. But for their substantiality and fair prices, these fittings in the foreign markets would wage only an unequal war against similar articles of tasteful design—the ornamentation executed in zinc, bronzed, or gilt, the parts held together with soft solder—produced by French artisans and manufacturers, or the tinsel fittings of the easily-fed light-working Germans, or those of America, turned out by facile and well adapted automatic machinery, for the invention of which the citizens of the United States are celebrated.

But while the external forms of ornamental fittings have been improved, and rendered more attractive, unity of style in one object is better preserved. Lightness and elegance, in connection with improved modes of finish, have followed as a consequence, though large quantities of stamped bodies, vases, arms, chain links, and other portions of ornament, are used up in the construction of the cheaper class of competitive work. The tendency is towards a superior class of fittings, in which light and elegant castings have taken the place of the ornaments alluded to as stamped. Improvements in tube making have not been without an influence, and Fearn's patent for ornamenting tube, extended in its application to the decoration of varied sizes of tubes, has placed in the hands of gas-fittings manufacturers the means of producing articles very much more attractive at a comparatively cheap rate. Even the removal of the fiscal duties on glass, by extending room for experiment in that material, has operated on the gas fittings' trade by the introduction of new forms of glasses to be placed over burners. A leader in this direction was Mr. John Hunt, now of the Hope Works, who introduced not only elegantly formed globes and shades of flint glass, but also others coated with opaline, and semi-opaque coloured glass, as shades for flexible stand reading lights, billiard lights, &c. Some ten or twelve years ago large quantities of glass and china ornaments were introduced and associated with brass construction, as vases, arms, and flowers. The demand for fittings with such decorations has, however, sensibly diminished, and they are now seldom asked for, except by purchasers of peculiar tastes. Even electro-deposition and photography have been pressed into the service for the production of the decorative parts of gas fittings. It is satisfactory, however, to record that mere novelty, apart from fitness, reigns only for a brief space of time—the fashion of the hour; and that now unity of material in brass only, is generally preferred in gas fittings.

Having described the ornamental portions of gas fittings, construction will necessarily form a part of the subject matter. Allusion has been already made, to the imperfect construction of the early examples of fittings, on the introduction of gas. As will readily be understood, all chandeliers or pendants were formerly stationary, they could not be raised or lowered. The introduction of a mode of construction by which this could be effected, and the light brought down or raised up, engrossed the attention and inventive skill of gas fittings' manufacturers and workmen. Among the arrangements first tried to effect so great and desirable an improvement, were stuffing boxes through which the tube attached to the body of the chandelier or pendant was appended, which worked telescopically, but the surface of the tube which drew down was unseemly; and it also diffused in the apartment in which the fitting hung an unpleasant odour, and the imperfectly purified gas deposited matter thereon which prevented the action of the slide. Racks and pinions were applied to effect the desired end, arrangements of helical springs tried, the internal tube was converted into a screw exteriorly, and the nut attached to the tube of the body of the chandelier, on being turned, elevated or depressed the chandelier. Atmospheric pressure was tried, but that which would sustain the weight of the chandelier at a low temperature failed when the apartment became heated, and this method also resulted in failure, and the simple water-slide, with its balance weights, tried at a comparatively early period, continues, and will continue, to be the simplest, best, and most useful arrangement for the purpose it is intended to serve, viz., to elevate or draw down the fitting of which it forms a part. Objections were long made to the unseemly appearance of the balance weights and to the fragile nature of the chain with which these were hung; the latter defect was partially met by the application of a hempen cord or gut string, externally covered with wire: this, however, failed also. The objection was eventually overcome by Mr. Isaac Clements, who produced a chain made of sheet brass, which may now be said to be introduced generally on all water-sliding gas fittings. The unseemly dangling character of the balance weights has also been in some examples got rid of by carrying the body of the chandelier up in the form of an ornamental sheath to the height of the external stalk. Between this sheath or ornamental cylinder and the internal tube or real stalk space is left, down which the weight, to counterbalance the weight of the chandelier, works. Externally, no counterpoise weight is seen, and the ornamental character of the chandelier is not interfered with. The internal arrangement of this object is on the stuffing-box principle, with means for lubricating the piston-like apparatus, which allows the gaselier to be elevated or drawn down. To Mr. John Hunt this arrangement is due. Considerable change has also been made in the construction of lobby lamps, which now take the form of elegantly cut globes or vases, apparently sustained by cords or rope-like tubes of metal, the central down rod being got rid of, the gas passing down one of the twisted tubes. This method of dispensing with the central tubes was suggested at an early period of the gas fittings manufacture by James Simpson, Esq., Advocate, of Edinburgh, more generally known as the author of the "Philosophy of Education." Flexible tubes for the conveyance of gas also gave rise to numerous modifications of table or reading stands. Mantelpiece lights are also now generally adopted in best houses where taste presides.

It may be interesting to know that since the introduction of gas, no fewer than ninety patents have been taken out for the improvement of burners only, and parts thereof. The accepted class of such articles may, however, be limited to very few. Jets with single flame are now rarely used, and "fish tails" or "Scotch jets" have taken their place. This class of burners, or "nibs," as they are called, are made of cast iron, and produced chiefly in and about Manchester. On the contrary, the great proportion of Argand burners (so called from their form resembling the circular wick lamp burner invented by Mons. Argand) are all or mostly made in Birmingham. This burner, taking into consideration the amount of light given, and its quality in proportion to the quantity of gas consumed, is certainly the most economical when skilfully made. The holes being uniform in size from which the gas issues, in the improvement of this kind of burner, terra cotta perforated plates have been applied instead of perforated steel or iron plates—the corrosion from impure gas sensibly corroding the steel or iron top away. The body of the burner was, and is still occasionally, cast. In 1847, however, the chief portion of the burner and glass holder, united in one, was produced by means of the stamping process, and a button was introduced, which rose up in the centre, and caused the flame to curve outwards. A glass was devised with special reference to the curve of the flame and cap, formed of wire gauze, or of perforated metal, which, fitted on the top of the glass, elongated the flame by increasing the draught or more completely consuming the gas. A few years afterwards, for the cap already named, a terra cotta concave disc was introduced, which, becoming heated by the lighted gas, consumed the carboniferous particles and other products unconsumed by Argand's without the terra cotta arrangement, or ordinary fish-tail, bat-wing, and other burners; these last improvements were also originated by the inventor already twice named.

The most recent improvement in connection with the manufacture of gas fittings, is in the substitution of cast iron, for lead, in the filling of the external covering or shell which forms the balance weights of water-sliding gaseliers, or pendants. The brass shell to be filled is placed in water, and the molten iron poured in. The water prevents the shell from being melted, its temperature never rising above 212°. Iron shot had been previously used for filling. The improvement consists in pouring in the molten iron, and the cheapness of iron in comparison with lead; but the specific gravity of lead is greater than iron, and it may be questioned whether the increase of size of shell, in many instances rendered necessary by the lightness of the cast iron, is commensurate with the difference in price between the two metals used, *i.e.*, iron or lead, and all the more that in the dipping operation the iron is more operated upon by acid than lead, thereby increasing the difficulty in finishing; if polished, or bronzed, the same objection does not apply. This improvement is the invention of Mr. James Atkins, of the Cambridge Street Works.

In fitting together parts of gas fittings in process of manufacture, it is now customary to avoid the use of soft or tinman's solder; the best houses in the trade invariably use hard solder; and the primitive method of screwing tubes into joints and stopcocks, trusting to white lead for tightness, even in brackets, branches, &c., is carefully avoided. The use of white lead, and leather, or card washers is reduced to an exception.

The Gas Fittings manufacture is one which has improved by competition as regards superior workmanship; and though leading articles may be somewhat lighter, they are better fitted, equally serviceable, very much cheaper, and better finished, than they were when they cost in some instances over one-third or a half more. These remarks apply to portions of fittings, as single and double brackets, and such articles as are used, of a plain character, in ordinary shops, bedrooms, and servants' apartments in houses, and also in public institutions. Where ornamental work is introduced in better class fittings, any comparison in price, of a satisfactory kind, cannot be made; but more and better work can now be had for a sum which, a few years ago, could only have purchased an article, the ornament on which was calculated to degrade rather than adorn. At the present period there is a greater demand for better and higher-priced articles than there was ever known before.

A new feature distinguished the gas fittings exhibited by Birmingham exhibitors in the International display of 1862, viz., the rich colour of the metal in which many of the chandeliers and more expensive articles were made. This was principally due to a greater preponderance of copper over the zinc used in the composition of the brass employed in their construction. If to this we add that the colour was rendered more brilliant after dipping in acid, by means of friction against brass wire brushes revolving in a lathe propelled by steam power or manual labour, (technically "scratch brushing)," and that then to say it rivalled the appearance of a more valuable metal, is no exaggeration. If to this is added the feature of a variety of many-hued bronzes over the limited range of colour in the bronzes or bronzings at the command of English metal workers previously, the advance is very marked as regards finish. One peculiar bronze, as applied to the class of work now under consideration, marked the year 1862; viz., the brilliant steely reflective black bronze produced from a solution of platinum (*i.e.*, the bichloride).*

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* For the information of the uninitiated, it may not be out of place to state the expression "bronzing" must not be confounded with the metal called bronze, used for statuary purposes; and that bronzing, to be properly understood in connection with brass, does not consist in covering the surface of the metal to be bronzed with an opaque pigment applied with a brush. It is either the result of chemical action, by which the colour of the metal is changed, or a coating of another metal is thrown down on the metal to be bronzed. Thus the common black bronze, the only kind at the command of the Birmingham brassfounders for a long series of years, was produced by the immersion of the article in a solution of acid and

Until very recently the component parts of ordinary Gas Fittings, as Main Taps, Stop Taps, Swivels, and Couplings of various kinds, were produced entirely by hand labour, and the operation of "plugging," or fitting in the keys or plugs to the taps and swivels, was performed by hand labour, the lathes only in some instances being propelled by a steam power. The operation was performed thus:—the barrel was bored out with a taper "rimer" or "borer," the plug was fastened in the lathe by screw, or clams; it was then turned down to a taper form, corresponding to the interior taper of the barrel or socket. This was arrived at by placing the barrel on the key, and observing, while the key rotated and the barrel was held fast, that the friction of the two produced the indication of a general coincidence. If they did not do so, the turning tool was again applied to the plug, till the proper bearing or taper was arrived at. Barrel and key were then seated by grinding together with loam—the set-off for the washer turned down—the hole for the screw having previously been drilled and tapped. The completion of the various parts, afterwards, as the squares of the joints, the heads of the keys, the finishing of the screws and washers, the filing away of portions of the barrels, to convert taps into stop taps, was all done by hand labour; and the consequent irregularity and imperfection, or perfection of the work, was entirely dependent on the amount of skill possessed by the workman.

That no successful attempt should have been made to produce these parts of Gas Fittings, known as Main and Stop Cocks, Swing, Universal, Swivel, and Union Joints, Bracket Backs, and Pendant Tops, previous to the year 1859, is matter of wonder, but that it has now been done and

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salamoniac, or spirits of salt and arsenic, or the two last-named associated with smithy iron scales. In the case of the two last mixtures, the articles were partially heated before immersion in the liquid; on being withdrawn they were black or of steely hue. They were then brushed with blacklead, and eventually coated with lacquer of a deep transparent yellow colour, which produced the ordinary green bronze, now but seldom asked for, or preferred. A lacquer of a more transparent colour produced a blacker shade; on the contrary, the base of the red bronze, or Venetian, or Florentine, is the result of a thin coating of copper, its shade being partially obscured by blacklead also; it is coated for protection with lacquer. All the bronzed zinc figures imported from the continent, and now so common in this country, many of which are very excellent copies of celebrated original works, owe their beauty of colour to a superficial coating of copper, varied by the application of chemicals which alter their hues; even the impress of age, the verdigris florescence which is supposed to give evidence of "hoar antiquity," and the presence of which is accepted by archæologists and the dilettanti as denoting the *bona fide* antique origin of the specimen, can now to be produced in a few hours. In bronzing, continental metal workers are still our superiors; the new colours of bronze are due to them, their scientific knowledge being superior to that of English workmen, and affording another strong proof of the necessity of chemistry, as regards the metals, being more generally studied by English artisans. It may, after the explanations given, be unnecessary to state that the colour of the bronze produced, as in bronzed articles, is only skin deep, and that a scratch reveals the original metal, the surface of which has been bronzed as already described.

is being done by one intelligent manufacturer, is a matter of satisfaction. The machinery employed is automatic in its operation, and is worked by levers. The successful operation of the machines, however, requires careful and skilful grinding and setting of the tools and cutters employed to effect the desired end. The principle involved in the "plugging" process is essentially that of the slide rest. In boring the barrels, the borer is fixed on an iron chuck in the lathe, and the barrel to be bored in the slide rest, which is then worked, and propels the barrel against the borer till the sand marks of the core are obliterated. The plug, or key to be fitted is securely fixed in suitable clams or grips, and the tool set, in order to produce a taper the exact counterpart of the interior of the barrel which has been bored out as described. The lathe is set in motion, the slide rest operated upon, and the result is—a plug which fits air-tightly the barrel of tap or joint. This effected, and the slide rest tool withdrawn, a tool and drill is brought up against the end of the key or plug; the former makes the set-off for the washer to fit on, the latter drills the hole for the reception of the screw, which, in connection with the washer, allows the joint, key, or plug to turn freely in its barrel. The set-off for the washer is finally squared, or made into a D form, by the key or plug being held firmly in a grip; a circular cutter cuts away the metal and produces the flat of the washer if D in its perforation. If square is selected as the form of the perforation of the washer, the position of the key is changed four times, the cutter brought to bear, and a square produced. A somewhat similar cutter and operation cuts away that portion of the tap barrel which converts it into a stop cock or tap; and the hole for the insertion of a stop pin in the key is also drilled by machinery. The screws for the bottom of the keys are made from a cylinder of metal, corresponding in thickness to the extreme diameter of the size of the head of the screw, also by the operation of cutters. Even the washers are turned in a correspondingly automatic manner by placing the perforated disc to form the washer on a perpendicularly rotating spindle, the upper end of which is formed into a projecting shoulder, corresponding to the form of the perforation of the washer, on this the washer is dropped; a cutter formed to produce the level of the external circumference of the washer is brought down upon by means of a lever, and finishes it. The heads of the keys, the squares of the plugs, and the nuts of couplings are also finished by means of suitably formed cutters. Without elaborate illustrations, it is almost impossible to convey any adequate idea of the ingenious mechanical arrangements invented to produce the results arrived at. Still it may be hoped that the brief sketch given will enable practical readers to comprehend that the work accomplished must necessarily be very superior in regularity and appearance, to that produced by mere hand labour, which is thereby reduced to a minimum, and is confined to simply "seating" the plugs by a trifling grinding with loam, and then lubricating them with grease to facilitate their easy working, and fitting them together. The ordinary *modus operandi* of producing the same class of works by means of hand labour has already been described, and may be referred to by way of contrast. While the advantage of hand labour in the formation and finish of the artistic parts of gas fittings, and in fitting the several parts together, will still remain a necessity, it may with confidence be affirmed, that the structural parts named can be better accomplished by means of automatic machinery. Sticklers for old modes of working may object to its adoption, and say—if the tools are not properly set, great quantities of plugs or barrels will be rendered useless. Granted: but on the setting of the tools and intelligent superintendence of the execution of the work, the success depends; and carelessness, ignorance, or something worse, can alone cause failure.

The system which we have attempted to describe has been perfected by Mr. Joseph Breeden, whose eminently practical knowledge in the manufacture of gas fittings is shown in the construction of the various machines calculated to accomplish the varied operations described. It need not be added that, to work the system profitably, considerable quantities of articles require to be produced, and in this the machinery employed forms no exception to the rule of the application of automatic machinery for the production of other articles in metal. "It is the quantity produced which pays." Various manufacturers, it is understood, have applied machinery without success, or with only comparative success. If they have failed, they must have done so owing to the inadequacy of the means they employed to accomplish the end; the imperfect construction of their machinery, or the want of care, skill, and practical knowledge in grinding the cutters, and setting the tools. It should not be forgotten that parts of articles very much more complicated than swing, swivel, and universal joints, and other parts of gas fittings, are produced by machinery; among others, portions of Gun Furniture, including gun locks, as they are produced at the Government Gun Factory at Enfield and the Small Arms Manufactory at Small Heath, near Birmingham; also the several parts of Mortise, Chest, Safe, and other Locks of Hobbs'. There is, therefore, no reason why Gas Fittings, so far as regards the parts named, should not be, as they are, equally successfully produced.

Ultimately it may confidently be predicted that machinery will be adopted for the production of parts of the common fittings by all the larger manufacturers in the gas fittings' trade. And as taste is improved and fashion operates, new forms and combinations of forms of fittings, to replace old and to supply new, will be called for. In the production of these, a greater amount of skilled labour, united with artistic feeling and knowledge, will be evolved; and the exercise of the powers of mind, in connection with superior manipulative skill, will certainly result in producing a superior class of workmen, the existence of which, really lies at the foundation of superior execution in works in metal, particularly brass, and as exemplified in the production of the best class of Ornamental Gas Fittings.

In order to illustrate the reduction effected in the prices of gas fittings, a comparison has been made of these as they appear in an old pattern book of the year 1820, with one now in circulation. It will at once be understood that the several parts of fittings were by no means so numerous nor so various as they at present are. The prices of similar articles of the two periods *will now be compared as under*:—

	1820.	1866.
A stiff bracket, straight, 12 inches long	5/-	1/9
Single ditto, back to swivel and cock, 12 inches long	8/5, 6/6	1/9½ 1/11½
Double ditto, ditto ditto	12/5	3/9
Single pendant, fast top, five-eighths down rod, three-eighths in bend	13/-	
Same article, but with swing top		5/6
Double pendant, same size and style of tube	19/6	
Ditto ditto, but swing top		10/-
Harp pendant	50/-	21/-
One-light pendants, formed with corona rim, cast, 15 inches diameter, three cut out of sheet metal link chains, and stamped rollers, behind one of which chains a small tube came down to conduct the gas; *no swing joint.* Other examples in which there were no chains, but with two tubes	33/-, 39/-, 44/-, 50/-	
One-light pendants, more useful and attractive, fitted with water slide		14/-, 21/-

	1820.	1866.
Two-light STIFF pendants or chandeliers, consisting of two tubes placed asunder and attached to two small brackets, by no means attractive	56/-, 60/-	
Another example, with down rod, cast body, with two scroll bunches attached, husk in centre of down tube, two chains . .	84/-	
Two-light water-slide pendants, with stamped or cast work		18/6
A three-light stiff, similar to the two-light, but with additional attractions in the form of a cast perch or lizard back pin	110/-	
Three-light water slides, very much more attractive, can now be purchased from .		25/- up to 50/-
Elbow Argand burners, 1 inch diameter. .	3/6	2/2¾
Crutch ditto ditto	3/8	2/5½
Three-jet Nib burners	10/- per doz.	/4½ per doz.
Batwing burners	9/- per doz.	/4½ per doz.
Three-eighth inch tap, long end and barrel .	1/8	/7
Nosepieces with jet or batwing . . .	15/- per doz.	2/10½ per doz.
Ball joints	10/-, 8/8, 8/-	1/1 to 2/3
One-inch main taps, internally screwed, no caps, ... each .	14/-	2/11
Three-fourth inch ditto ditto ,, .	5/4	1/7
One-half inch ditto ditto ,, .	4/-	1/3½

It would have been interesting to have carried out the comparison further, but unfortunately we have not the means for doing so, as the old pattern book referred to contains only representations and prices of articles stated or compared, with the exception of scroll brackets, which in the 1820 book are priced from 11*s.* 6*d.* up to 24*s.* for 12 inch. Equally good can now be purchased from 5*s.* up to 17*s.*, and rendered more attractive by the introduction of ornamental tube, and very much better designed scrolls, &c. The slight difference in weight of metal does not at all—even admitting the articles priced in the 1820 book to be heavier—account for the difference in price. The increased demand for fittings of all kinds, whether plain or ornamental, has operated beneficially in not only reducing the price, but in producing a superior article as regards design, workmanship, and finish. On the authority of a practical manufacturer it may here be stated, that workmen engaged in the leading parts of the gas trade are now getting higher wages, or more money than they did fifteen or twenty years ago. If more work is done for the money earned, its execution is facilitated by appliances which at an early stage of the manufacture did not exist; the filing of key heads, or the squaring of the plugs, is not now effected by the hand labour of boys, but by machinery. Plugging has become a mechanical operation, and the skilled labour absorbed in the production of mill and other common fittings, taps, &c., has been turned into other and more profitable departments of the manufacture, where there is a greater necessity for skill and intelligence, and in which it can be displayed.

As regards the manufacture of gas fittings, they may be said to involve the highest class of talent at command in brass manufactures, viz., that of the designer and modeller. In the majority of manufactories the designer is the modeller also. In one or two establishments the designer confines himself to the production of designs only, leaving to the modeller the production of the designs in wax, pipe clay, &c. The repairers and chasers are employed in the "work" in chopping up or rendering the parts of the castings from the patterns sharper and more distinct in the detail. Experienced workmen are required for fitting the several parts together of chandeliers, &c.—"Dippers," to "dip" and "bronze" the work, and "burnishers" to burnish it. Boys and lads afford considerable assistance to workmen. The latter, when quick and expert, earn fair wages. Female labour is seldom taken advantage of in the gas fittings' trade, and is generally confined to the lacquering and the wrapping up of the finished goods. Workmen who undertake to execute work complete, including dipping and burnishing, and pay their own workmen, frequently earn from £2 to £4 per week. Workmen who work separately, from 25*s.* to 35*s.* per week. Dippers and bronzers, 20*s.* to 25*s.* per week. Lads between twelve and eighteen years of age, 7*s.* 6*d.* to 17*s.* Boys, 3*s.* 6*d.* to 6*s.* Lacquering women, 8*s.* to 10*s.* per week. In the early part of the year, when the winter orders for the home trade are completed, and no foreign orders are in hand, there is frequently a little slackness in demand, but such periods are taken advantage of by manufacturers to revise old patterns and prepare new for the ensuing winter trade.

9.—NAVAL AND ORDNANCE BRASSFOUNDRY.

Originally a considerable number of the articles included in the department designated as Naval Brassfoundry were produced by manufacturers of cabinet brassfoundry, and to some extent they still are and continue to be represented in their pattern books, these articles are, however, limited in variety, and confined to Cabin Hooks, Lashing and Rope Eyes, the smaller varieties of Hinges, leaving the great majority of objects or appliances in brass and gun metal for ships' use to be made in the towns where ship building is practised, as London, Liverpool, Bristol, Glasgow, Greenock, &c. The increase in the commerce of this country and in shipping yearly, has not been without its influence on the brass trade. It has been already shown, in reference to the engineering trade (that such articles as steam-taps, pressure gauges, whistles, and other brass articles made in engineering establishments) have been transferred to be manufactured in Birmingham; so in like manner the great quantities of articles made of brass for ship building purposes have now been transferred to this town for production or manufacture, and arose as a special department of the brass trade in the year 1844, when Mr. James Marrian, of Slaney-street, commenced a manufactory for the production of the various special articles in use by shipbuilders, uniting those already, or formerly made. In this he was aided by skilled workmen acquainted with the technical peculiarities and uses of the articles required. Various regulations issued by the Office charged with the Marine Administration of the country, by the Board of Admiralty, as regards seagoing and coasting vessels carrying signal lights, have in no small degree operated in extending this branch of trade. The specialities which distinguish the articles produced are their substantiality as to material, thorough good fitting, workmanship, and finish, all of which require an amount of strength, to resist wear and tear, the hard usuage to which they are subjected by the war of elements, and consequent strain to which they are exposed when in active service. Among the specialities produced may be named receptacles for ships' compasses or binnacles, portlights or scuttles, by which light is admitted and the sea excluded, decklights for a similar purpose, lashing and rope eyes, ring bolts, pulleys of an ordinary kind, and others with friction rollers in order to diminish friction to a minimum; strong and substantial hinges of various forms, adapted to suit the several purposes of the doors to which they are attached, and which swing on them; quadrants of various forms to regulate the opening of the down sashes; sash lifts, rowlocks, belaying pins, cabin railings, so useful to provide sea legs for landsmen; stair and poop railings, stanchions, basin rings, hasps and staples, and boat hooks; and an infinite variety of means of artificial lighting in the form of candle and oil lamps, fitted up with gimmal joints in order that in whatever position the ship is placed (or whether she lurches or rolls) the lamp retains its vertical position, the oil and wick, or candle, remains in its receptacle, and the light continues to burn. Taps, valves of various kinds, pumps and other articles adapted for sanitary purposes on shipboard, are also included among the articles made. Allusion has been made to the regulations issued by the Admiralty in reference to signal lights for attachment to various parts of ships, in order to prevent collision. These take the form of lanterns, of a very substantial character, glazed with various coloured discs of glass; occasionally the glass is globular. In every case the glass of these lamps, whether marked for masthead, port, starboard, or anchor, is either protected by bars, or so sunk into the metal frame of the lamp that injury to it under even extraordinary circumstances is nearly impossible. Bells mounted on brass frames or standards, and signal cannons or brass guns, fitted in working frames, and appliances for the burning of various coloured lights as signals, indicate somewhat imperfectly the various articles which come within the province of the manufacture of the Naval Brassfounder.

Ordnance Brassfoundry, as its name indicates, deals with the production of articles connected with fittings for artillery. The guns themselves, if of brass or gun metal, are chiefly cast at Woolwich, and turned and bored out there; but the fittings have been largely produced in the establishment already named. These fittings, however, it should be understood, are applied not only to brass or bronze guns, but also to the best varieties—as the Whitworth, Armstrong, and others—made of wrought or cast iron or steel. The Crimean, Indian, and Chinese wars, more especially the Crimean, it will be recollected, directed the attention of the authorities at the War Office to the improvement necessary in implements of war, and particularly to the defects in ordnance. The result was, that not only in the structure of the guns, the material or metal of which they were made, but in the appliances to secure certainty of aim and discharge, improvements were introduced. Thus the detonating or hammer lock replaced the lighted match of the gunner, and "sights" attached to the end of the gun furnished the means of correctly pointing it so as to cover the object aimed at or the point against which the fire was directed. The arrangement of a screw aided the director of the gun in elevating or depressing, and maintaining it in position till discharged; and the fuzee, graduated in order to effect the explosion of the shell in which it was introduced, at the calculated distance where it fell, increased the efficiency of the destructive missile.

Of such aids to modern warfare as percussion or hammer locks and covers, tangent sights, elevating screws, fuzees, &c., large numbers were produced during the progress of the recent wars, and still continue to be produced from time to time in the establishment named. 3,000 shell fuzee were orders frequent during the war.

The articles mentioned, and others of an analagous character, indicate the sphere of operations and the productions of Ordnance brassfoundry.

The processes involved in the production of the Naval and Ordnance brassfoundry articles are similar to those practised in other departments of the finished brass trade or manufacture, viz.—casting, filing, turning, and screwing. The style of finish, however, is somewhat different in the majority of the articles, and is technically known as "sanded," *i.e.*, produced by passing over the article, when filed flat, sand, or emery paper, or cloth, in the direction of the file marks, and thus producing uniformity of surface. In turned articles, after turning, the sand, or emery paper, or cloth, is applied to the article revolving in the lathe. The articles are then protected from oxidation by lacquering, dipping, or bronzing; and burnishing is practised, as already described. In the more ornamental examples, as lamps for saloons and railings for cabins, &c., the composition of the brass is similar to that used for articles of ordinary brass manufacture; but in large hinges and Ordnance fittings, gun or bronze metal is adopted, composed of ten parts copper and one part of block tin. The wages of workmen vary from 15*s.* to 25*s.* per week; superior workmen, employed on best work, earn from 25*s.* to 30*s.* Women are not engaged in this trade except as lacquerers. Lads earn from 3*s.* 6*d.* to 7*s.* 6*d.* per week. Casters are paid per cwt. for the work produced, whether common, common fine, or cored work. At present there are about eighty hands employed in the manufacture of Naval brassfoundry and Ordnance fittings.

As the greatest difficulty has been found in arriving at the periods when the several departments of the brassfoundry trades became separate branches, it has been deemed important to record, for the benefit of future enquirers, the origin of this branch of manufacture, which promises in future years to become much more extensive and complete than it is at present.

At an early stage of the enquiry which has resulted in this report, 400 circulars were sent out, addressed to manufacturers engaged in the production of raw material, as sheet metal, &c., and also to others who made finished brass articles. On the fly-leaf of the circular a list of materials consumed in the brass trade was given, with a request that it might be filled up and returned to the Chairman of the Industrial Committee. Of these circulars, 29 were returned as "dead letters," 12 without any information, and of 327 no notice was taken.* Only 32 contained information of the kind desired, and one was returned signed by "An overtaxed manufacturer," with the request that the Committee would kindly inform the public, through the press, if these papers were destined to come into the hands of the Assessors of Taxes. From the 32 circulars, the editor of this volume selected 17 returns, which bore evidence of being of a *bonâ fide* character, and gave the figures to the present writer, who has added the consumption of material in one establishment. The results are as follow:—

MATERIAL CONSUMED ANNUALLY BY HOUSES ENGAGED IN THE BRASS MANUFACTURE.

	By 17 Houses.	By 1 House only.	Total Consumption by 18 Houses.
Brass, in Tons	1,725		1,725
Copper	1,030	450	1,480
Iron			
Zinc	950	250	1,200
Lead	40		40
Tin	80	50	130
Coals	10,414	4,000	14,414
Coke	1,000	1,050	2,050
Aquafortis (in carboys, by number or weight) Tons	32	21¼	53¼
Oil of Vitriol ,,	6	12	18
Lacquer (*Best*, in gallons)	109	250	359
,, Methylated	1,889	800	2,689
Argol (by weight) lbs.	1,112		1,112
Number of Furnaces usually at work	86	15	101
,, Casting Pots of Stourbridge Clay	45,972		45,972
,, Plumbago	56		56
Rolling Mill, pairs of rolls	34	8	42
Muffles for Annealing Metal	25	3	28
Number of People Employed.			
Men	1,095	450	1,545
Boys	632	270	902
Women & Girls, as Lacquerers: Chargers of Tube, Press Women, & Wrappers-up	217	70	287
Modellers, Chasers, or Pattern Makers	19	10	29

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* [As each of the circulars sent out had a *stamped* and addressed cover for the return, the 327 manufacturers have benefited by this enquiry to the extent of one penny each.—EDITOR.]

CONSUMPTION OF MATERIAL IN THE BRASS TRADES AND ITS EFFECTS ON OTHER INDUSTRIES.

By the return already introduced from only a few manufacturers, some idea of the quantity of material used in the brass trade may be formed; but it is not only the immense consumption of copper and zinc which forms the component parts of the metal brass, or the labour absorbed in the trade itself, which make it so important an element in the trade of Birmingham. The immense quantity of coals consumed for steam engines, the coke which is used for heating the furnaces in which the metal is melted, and in soldering stoves, the Stourbridge clay consumed in the making of crucibles, the tons of loam and sand quarried for forming the moulds, the wood charcoal ground into powder for dusting the moulds, and the bean and other flour with which the moulds are dusted form a vast addition to local trades. Besides these natural products, chemical science contributes largely to the materials used; of these, boracic acid from the lugoons of Tuscany, in the form of the borax of commerce, is consumed in tons for soldering purposes. The lead chambers of the acid manufacturer supply thousands of carboys of oil of vitriol, for cleansing the rough oxide from the surface of the tubes and metal which have been soldered; and larger quantities of nitric acid or aquafortis are used for dipping purposes. Crude tartar, in the form of powder, (the deposit found at the bottom of wine casks) and called argol, is also used in connection with the operation of dipping. Also spirit of wine—the spirit in which seedlac is dissolved to form the lacquer used to protect brass work when finished—is consumed in immense quantities; and the brown and white papers in which the goods are wrapped up, may alone be estimated by thousands of tons, and the superficial area which produces elm and other timber used for making the packing cases and casks is very great. It is yet a doubtful matter, whether methylated spirit of wine is equally good for lacquer-making purposes; but the removal of the fiscal duties from spirits of wine to be used for manufacturing purposes by the introduction of methyline (largely promoted by the exertions of the late Henry Smith, Esq.,) has been no mean boon to the brass trade. The abolition of the duties on paper has been equally beneficial, and modern chemistry, as applied to manufactures, has in no direction operated more efficiently than in the reduction of the prices of aquafortis and oil of vitriol. The former, sold prior to 1802, at 5*d*. per lb., can now be had at

2*d.* per lb.; the latter, we are told, sold prior to 1800, at 8*s.* per lb., in that year it was reduced to 1*s.* per lb.; it is now sold at 1*d.* per lb.

In order to show the quantity and value of metals consumed in one year, in the brass manufacture, the following estimate is introduced:—

TOTAL CONSUMPTION AND VALUE OF METALS CONSUMED IN THE BRASS MANUFACTURES OF BIRMINGHAM IN THE YEAR 1865.

	Tons.	Rate per Ton. £	s.	d.	Value. £
Copper consumed in finished Brassfoundry, Gas Fittings, &c.	2,000	...			...
Copper consumed in Yellow Metal Sheathing, Bolts, &c.	6,000	...			...
Copper consumed in Locomotive and Marine Boiler Tubes	5,000	...			...
Copper consumed in Telegraphic Copper Wire, Brass Wire for export, Pins, Screws, and other purposes	4,000	...			...
Copper consumed in Rolled Brass, not Sheathing	2,000	...			...
	19,000	at 86	0	0	1,634,000
Old Brass, Sheathing, as Muntz's, (returned for remelting)	5,000	,, 60	13	4	303,333⅓
Old Locomotive Tubes, as Green's solid tube	2,000	,, 60	0	0	120,000
Old metal received from the sweeping of shops, turnings, filings, and caster's dirt, and collected by hawkers, and in the country	1,000	,, 56	0	0	56,000
Spelter, or Zinc, used in making Brass	11,000	,, 21	12	0	237,600
Block Tin, used in making Bells, Mill Brasses, Gun Metal Castings, Tin Solder, Patterns, &c.	200	,, 94	0	0	18,800
Lead, for filling Balance Weights of Water Sliding Pendants in Patterns, Solder, and in Cock Metal	100	,, 19	5	0	1,925
					£2,371,658⅓

The next table illustrates the increase of establishments and manufacturers engaged in the brass manufacture, at three separate periods, *i.e.*, 1800, 1830, and 1865.

	1800.	1830.	1865.
Manufacturers entered as Brass Founders and Stampers, &c.	28	144	176
Bell and Cock Founders, Plumbers' Brass Founders, &c.	6	32	39
Brass Candlesticks	6	17	14
Brass Casters	2	10	42
Curtain Rings	2	5	4
Brass Nails	1	9	3
Rolled Brass and Wire	5	17	31
Tube Makers	0	12	20
Lamp, Lustre, and Chandelier Makers, for oil and candles, and small ornaments, in 1865, including Paraffin Lamps, also Gas Fittings Manufacturers, same also being included under the generic term of Brass Founder	0	29	63
Gas Fittings	0	5	25
Mediæval Brass Foundry	0	0	4
	50	280	421
Number of Manufacturers by enumeration	50	160	216

Thus in 1800 there were engaged 50 manufacturers in apparently seven branches of the manufacture; in 1830, 160 manufacturers in eleven branches; and in 1865, 216. The number of establishments shown—280 in 1830, and the 421 in 1865—arises from manufacturers engaging in several branches of the business, and their being entered in Directories under the several headings. Accepting the latter arrangement, the result is as follows:

1780	50	1825	163	1847	301
1783	78	1833	174	1853	357
1821	112	1848	178	1865	421

INCREASE OF MANUFACTURERS.—IMPROVEMENTS IN MANUFACTORIES.

The increase of the number of manufacturers is, however, less an index to the expansion of the Brass Manufactures of Birmingham than the extension of the premises of many old establishments, and the increased number of hands now employed therein. Formerly, with the exception of such manufactories as those of Timothy Smith and Sons, Messenger's, and the Cambridge Street Works of R. W. Winfield, who in the beginning of the present century erected new premises, the works were small, and the workshops low-roofed and imperfectly lighted. They were in fact dwelling-houses converted into workshops, and were chiefly situated down courts, the manufacturer residing in the house in front. Suburban residences in the early days of the Brassfoundry trade had not come into fashion. The manufacturer was not unfrequently his own "rough warehouseman," and some 20, 30, or 40 workmen included, his whole productive power. They treddled the turning lathe, and he, not unfrequently, begirt with apron, examined the work, tied it up, made out the invoice, and sent off the finished work to its destination. This primitive state of things has, however, changed, and within the last twenty years manufactories have been specially built with reference to the requirements of the manufacture, the workshops frequently large, roomy, often well ventilated, (though too little attention is still paid to ventilation,) surrounding, in many instances, the three sides of a square, with offices and warehouses in front. Shafting, worked by steam power, is led into the shopping to drive the lathes. The casting shops are separate buildings, high-roofed, with means to allow the escape of the noxious fumes arising from the metal when pouring. Special provision is also made for "dipping," and a supply of water is in the immediate vicinity of the shed, in which also provision is made to allow of the escape of the acid vapours. The same holds good in reference to lacquering rooms in newly-erected works. Formerly these consisted of a miserably small and cramped room, with a couple of iron plate stoves or hot-hearths, presenting 48 feet of iron heated to a high temperature, and a low roof, rarely exceeding 11 feet in height, the room itself in size 12 by 15 feet. In this room some five or six females worked. Now these rooms are of large dimensions, and with high roofs. If so much has been done in the manufactories and appliances for the production of finished brass goods, an equal change for the better is recognisable in establishments for the production of sheet metal, wire, tube, &c. For the creechy rolls, the primitive draw-benches, and clattering wire blocks, rolls of great size and power, fitted into massive iron frames with adjusting indexes, drawbenches with admirably fitting trains of wheels and chains of great strength, and wire-drawing blocks well fitted, revolving truly and silently, have taken the place of their imperfectly constructed representatives in a preceding generation, and demonstrate the advantage taken of improved mechanical skill to facilitate production and lighten labour. At the same time it should be stated that the buildings in which the new machinery is fitted up are large, ample, high-roofed, and of course on a ground floor. All the workmen being seen at once, the means of inpsection and supervision are thus materially simplified,and the contrast afforded by comparing the new with the old establishments, of which some are still in existence, is very startling. Allusion has been made to increase of workmen in manufactories of comparatively long standing; thus some Cabinet Brassfoundry establishments, which ten or twelve years ago employed each about 60 or 80 hands, now employ from 150 to 200 each; and one house which embraces several branches of the Brass trade, and which in 1835 employed not more than 100 workmen, now numbers 800. A document which came into the possession of the writer is curiously illustrative of the progress of the establishment named, and shows the following changes:—

In 1835	110	Workmen
„ 1849	433	„
„ 1852	700	„
„ 1866	800	„

The payments of workmen, for the month of April, in the years named, in the same establishment, were as follow:—

1840	£721	16	5
1842	848	13	3
1844	944	10	1
1845	1,176	17	5
1866	2,872	17	3¼

The number of workmen and payment of weekly wages would no doubt, in other establishments in the brass trade, show proportionately increased numbers, and increased payments, thus marking unmistakeably the vast increase in the number of workpeople made in five-and-twenty years.

INCREASE OF WORKMEN AND WOMEN.

The growth of the manufactures in brass is further demonstrated by reference to the increase of the labour employed therein, but there are no means of obtaining such an estimate earlier than thirty-five years ago. The following shows the increase, and by no means overstates the amount:—

NUMBER OF WORKPEOPLE MALE AND FEMALE OF ALL AGES ENGAGED IN THE BRASS TRADE IN THE FOLLOWING YEARS:—

1831	1,785	1841	3,408

1851 AND 1861 SHOWS THE NUMBER OF EACH AGE, AND SEX, AND 1865 SPECIALISED AGES OF LACQUERERS.

	1851		1861		
Males above 20	3,081		3,836		
„ under 20	1,833		2,379		
		Males 4,914		Males	6,215
Females above 20	1,111		988		
„ under 20	670		725		
		Females 1,781			
		6,695			
Lacquerers above 20			227		
„ under 20			179		
				Females	2,119
					8,334

If an increase is added equivalent to half the census period it may be assumed that at present, 1866, the number of workpeople employed in the Brass Manufactures is not below 9,500, especially if it is taken into consideration that the demand for labour is increasing, consequent on the rapid extension of the trade.

As regards the remuneration of workmen, &c., the brass trade certainly does not stand in an inferior position, and considering the almost constant employment which it affords to all willing to work, it may be esteemed a desirable occupation. That the remuneration or rate of wages is not declining will be gathered from the following extract from a letter written in 1845:—"May 12th,—The wages of workpeople do not fluctuate much in this establishment, many of the people are paid according to their earnings, *not per day*, but by the piece. The general rates, whether day or piece-work, are as follow:—Best workmen 30*s.* per week; ordinary ditto, 20*s.*; caster, 30*s.* caster's youth, 10*s.*; lacquerer, 10*s.*; wrapper up or warehouse woman, 7*s.* 6*d.*" Best workmen, especially those who can work and superintend, now realise very much higher wages, casters get more, and good and intelligent warehouse women can always command considerably above the amount named.

Upwards of twenty years' experience in connection with the trade suggests to the writer that Hutton's remark, made in 1780, about "the master knowing his way to affluence, and the servant to liquor," is true as regards the first part of the assertion, but the last is now only true exceptionally. The workmen in connection with the brassfoundry trade, as a body, in sobriety are not inferior to any other class of workmen engaged in other industries. They are prudent and careful, many of them possess houses of their own through land and building societies, and not a few have, by saving, accumulated money. Their dwellings have frequently trim gardens attached, and offer a favourable contrast to the squalid poverty observable in workmen's dwellings engaged in other departments of industry; while Factory Clubs and Sick Societies encourage habits of prudence. Where workmen are irregular—such irregularity arising from intemperate habits—the writer is of opinion that there is often a lack of proper supervision on the part of those in authority; an experience gathered by connection with upwards of 1,200 workmen leads him to this conclusion.

There is, however, another side to this picture, and we now turn to it for consideration and examination, as shown in—

DISEASES OF THE WORKPEOPLE ENGAGED IN THE BRASS MANUFACTURE; FEMALE LABOUR, ETC., ITS EFFECTS, PRESENT AND FUTURE.

The diseases common to the brassfoundry trade are chiefly of a pulmonary nature, and arise, in the case of finishers, from the dust evolved in filing the brass; and in casters, from the dust which rises during moulding, and the condensed fumes of the volatised zinc from the melted brass in the operation of pouring.[*] Brass casters are almost unanimously said to be short-lived; and the writer of this, from practical experience, founded on observation, concurs in the verdict. On this head, it should be remarked, that the liability to the diseases named may be largely checked by a more efficient system of ventilation in finishing shops, and the position of casting shops. The latter especially should not be under work shops, but entirely apart, with nothing built over them, and should be high roofed, with sky lights to open to allow of the speedy escape of the fumes of the molten metal. The state of the weather often determines the succession of attacks, which are more frequent in foggy or heavy weather, when the fumes escape more slowly. There is also the consideration, that in many of the recently erected brassfoundry works, while the castings' shops have been built separately, they have been built in the centre of a square or yard, but being lower in elevation, they stand as in a well—the fumes escape but slowly—and then penetrate into the workshops surrounding, invariably with sashes open for ventilation, or through broken panes of glass. The chimneys of the casting shops, though high, do not operate in carrying off the fumes; these, by their specific gravity, taint and vitiate the air in the square of the manufactory. On this subject, Dr. Greenhow remarks, "few of the casters past middle life are entirely free from difficulty of breathing, attended by more or less cough and expectoration;" though it should be stated, that in all probability "the large quantity of beer consumed may materially aid the development of the asthma-like form of the disease." C. Turner Thackrah, who wrote in 1832, also clearly describes the form of disease under which brass casters suffer—and says, "it affects the respiration, and less directly also the digestive organs; it is attended with difficulty of breathing, cough, pain at the stomach, and sometimes, morning vomiting. In Leeds, we did not find one brassfounder forty years of age." Thackrah, however, admits that later investigation resulted in finding two—one of sixty, and the other seventy years of age.

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[*] Dr. Percy mentions an "evergreen" practical brass maker seventy years of age, who for sixty years had been engaged in the trade, did not get a continuous night's rest out of five nights every week during that period. yet he appeared vigorous, and by *no means unhappy.* Exceptions don't form the rule. Experience is against Dr. Percy.

As a general rule, in Birmingham the Brass Finishers do not appear to be a long-lived race; but exceptional cases will be found of workmen at work at the age of sixty. Brassfoundry operatives employed in finishing do not seem to suffer directly, if the ordinary laws of health are observed. In one department of the operations in brassfoundry—that of Acid Finish or Dipping—it may be confidently asserted that there are not any dippers reaching the age of sixty years who have practised the operation from early youth. In such cases also the respiratory organs and stomach suffer. The popular remedy among dippers for obviating the effects of the acid is copious draughts of milk. Here also, as in casting, the effect of the acid is more apparent in cloudy weather, when the fumes are dissipated with difficulty, and in summer, when the acid is affected by the heat, evolving the fumes more copiously.

The prevalence of diseases of the nervous system and of the organs of respiration as affecting in-patients in the General Hospital, amounting to, from June 30, 1864, to July 1, 1865, 261; and as out patients to 1,542 cases, leads to the conclusion that the diseases of the respiratory organs might be diminished by a greater attention to proper ventilation, and that those of the nervous system might also be diminished by a less amount of female labour. At first sight there seems no connection between female labour and nervous disease; but not only single women are employed in the brass trade, but mothers of families too. Birmingham operatives marry early: the girl-wife becomes a mother, but, from early associations, she likes the manufactory better than her home—likes the company of the workers, and her earnings "help to keep the house." As soon as she can go to the manufactory after her confinement she goes (the absence on these occasions rarely exceeds one month), and the infant is left the greater part of the day to be fed on artificial food, and is usually attended to by a child not more than six or seven years of age. The food is generally indigestible—illness is the natural consequence of this unnatural mode of feeding infants. Children, healthy at birth, dwindle rapidly under this system, fall into bad health, become uneasy, restless, and fractious; opiates are administered to produce sleep and allay these symptoms; the result is, the seeds of nervous disease are sown, and, in the majority of cases, early death ensues. An operative of the better class stated "that he collects money for the expenses attendant on deaths of children—150 females are employed in the factory he is connected with—and he believed that ten out of every twelve children borne by the married women in that factory die within a few months after birth." In the united parishes of Birmingham and Aston the death-rate of children was as for the ten years, *i.e.*, 1851 to 1861 :—

In Birmingham, at less than One Year of age			14·121
In Aston,	ditto	ditto	5·175
In Birmingham, between One and Five Years			11·469
In Aston,	ditto	ditto	3·752
		Total	**34·517**

Deaths arising from phthisis are excluded from the causes of death given. The mortality is traceable to infantile diseases, entirely attributable to the want of the tender care of the mother in feeding and attending to her offspring. Medical statisticians are quite aware that under ordinary circumstances infantile complaints are by no means so fatal. The diseases from which these children died are stated to have been diarrhœa (no doubt attributable to improper diet); injured respiratory organs, (arising from cold and inattention); nervous disease, (encouraged by the use of opiates); small pox, scarlatina, measles, and whooping cough, (the fatality doubtless occurring from the want of necessary care in nursing, owing to the absence of the mother at the manufactory.) The population of Birmingham, including Aston, at the census of 1861, amounted to 290,076, and the infantile deaths within the ten years between 1851 and 1861 amounted to 34,517 ! ! or nearly one-ninth of its population, strangled it may be said at the portals of existence. Is there not here grave food for reflection? does it not demonstrate the baneful effects of the employment of married females in manufactories? Thus children, imperfectly fed, with constitutions feeble at first, and partly enfeebled by the use of opiates, uncared for in infancy, uneducated in childhood, at six or seven years find their way into factories, and become the male and female helps. They in turn, at an early age, become the feeble parents of a feebler offspring, and the grand type of the English workman is lost, or rapidly disappearing, and being replaced by a physically inferior race, with less muscle, of lower stature, with the nervous system exalted, and the powers of endurance diminished. While the writer of this desires in the future no Utopia or fabled Atlantis, yet there are certain principles impressed originally on all created things; laws, which to obey is life, to neglect is death. These laws operate unceasingly, regardless alike of man's cupidity, or ignorance. Experience shows that imperfectly developed parents produce an enfeebled offspring, physically weak, and prone to disease; that the best nurse for a child is its mother; that at certain periods the frame of woman requires rest and immunity from labour; that the tender years of youth should not be passed within the walls of a factory, or the frame subjected to labour during its growth; that youth is the season when the elements of education are best imparted; but all these several important considerations are ignored by the present system of factory labour. Dr. Greenhow's able report on Public Health, in 1861, remains unchallenged as regards the death-rate of children and the employment of women; and Mr. E. White's report in reference to the employment of children in the hardware manufactures has been questioned only as to the truth of some of the statements. All these, however, cannot be errors. At the bottom, no doubt, lies a solid substratum of facts, by no means flattering to our vanity.

While female labour and the employment of juvenile assistants are, in all probability, less common in the brass trade than in others, still, as an integral part of the great factory system, it is not blameless. (There are 2,119 females, being one-fourth of the labour employed in the brass trade.) While admitting that in certain operations in the brass trade, such as lacquering and wrapping-up, women may be employed with advantage to themselves, unmarried females should alone be employed. Married women should be excluded from any such work, as also from the use of the press in cutting-out and piercing, and other operations which they now undertake, and for which they are physically unfitted. The "piece" system of payment favours the employment of juvenile labour, as the manufacturer pays for the work brought in, and seldom exercises any control over the "helps" of the workmen who undertake it. In the same manner numbers of girls are employed by forewomen who undertake to do work by the piece. Here also no restraint is exercised. Thus the system of female labour and juvenile employment, fostered by ignorance and competition, has grown and is increasing, resulting in the neglect of the preparation for household duties and the attractions of a home. "Many of the children die, the mothers become familiarised with the fact, and speak of the deaths of their children with a degree of *nonchalance* rarely met with among women who devote themselves mainly to the care of their offspring;" and these are the mothers who deliver over the child of six or seven years of age to the foreman or other operative for a paltry sum of 1*s.* 6*d.* or 2*s.* per week—the price of childhood neglected and natural affection lost. Liberty not unfrequently means license, and Legislative interference is frequently uncalled for; but, in the wholesale employment of female and juvenile labour, it is surely justifiable to place some limits on such degrading work. Legislation has borne good fruit as regards other industries, and though less abused in the hardware trades than others, still a little wholesome interference would be productive of much good—in all probability less with reference to the *present* than in the *future*; but as all legislation should deal with the future, a present check would be beneficial. With advanced views in education, it appears preposterous to send children to work uneducated; and females intended by nature for the helpmates (not the competitors) of man, in the discharge of domestic duties; to convert these two elements into manufactory helps may for the present assist the competitive contest, but what of the future? Nemesis lives in the abuse of the natural laws—if persisted in the mechanics of England will become an undomesticated race, ale-houses will take the place of household hearths, and their children become *gamins* in the truest sense of the word. It needs no Government enquiry to tell us "*that in Birmingham the proportion of married women who work in factories, away from home, is undoubtedly increasing*," and, as a natural result, preparation for domestic duties is being ignored, homes are uncared for, and juvenile life is recklessly sacrificed.

Having already pointed out the influences which have led to the extension of the trade, as new branches of manufactures resulting from discoveries made by scientific men, and the practical application of their discoveries, as in gas lighting, locomotion, &c., &c., there is yet another element which has operated, and which in any paper dealing with the history and progress of an important branch of local industry, should not be passed over—the element of Taste, rendered visible in Art, as displayed by Industry. Readers, who have watched the progress of the brass manufactures in Birmingham, must be aware that within the last twenty years, the ornamental features introduced on the objects produced are of a much higher character, and approximate more nearly to good ornament than formerly. The means by which this progress has been made, it may be said unhesitatingly, are the issues of illustrated works, directing attention to the application of art to industry; Schools of Art; and, more potent still, Exhibitions of Manufactures, as the local Exhibition of 1849, and the International Exhibitions of 1851, 1855, and 1862.

LITERARY AND PICTORIAL INFLUENCES WHICH HAVE OPERATED ON THE BRASS TRADE.

As regards pictorial and literary influences on the ornamental brassfoundry trade, not much could be expected from such works as Piranesi, Stuart's Athens, or Cottingham's Designs for Metal Works, confined, where used, to the designer only. To workmen these were sealed books, and these books in time circumscribed the style of work designed and produced. The process of designing then consisted of drawing pieces from the works named, and sticking them together. In the year 1839, the Art Journal appeared, and took up the subject of Art applied to the results of Industry. It grappled manfully with the question of applied ornament, and showed how utility and beauty could be combined. Woodcuts illustrated the descriptions of the pen, and new forms were presented for the consideration of the designer. The work being cheap passed into the hands of the artisan; and then began that improvement in designs in metal, which has not ceased, and will not cease so long as Birmingham produces metal work. To S. C. Hall, Esq., F.S.A., the editor of the work named, is unquestionably due the merit of introducing or originating a work which, while it educated the taste of the purchaser, operated on that of the producer, designer, and artisan too. Other competitors entered the field, but failed; and still, month after month, the Art Journal conveys its lessons of art, and its illustrations of art and industry to the amateur's library, to the designer and modeller in their manufactory studio, and to the artisan in his workshop. The bold, energetic, and instructive writings of Augustus Welby Pugin, illustrated by his etching needle, though at first they found only few readers, yet such few were well fitted to disseminate true principles; the writings of Matthew Digby Wyatt, particularly his great book on Metal Work, admirably illustrated, and with descriptive notices of the history and processes of metal working; the Industrial Arts of the Nineteenth Century; the Grammar of Ornament, by Owen Jones; the Illustrated Catalogue of the Exhibition of

1851; Cassell's Illustrated Exhibitor, and other Works, have all been silently operating in improving and elevating the taste alike of buyer, manufacturer, and workman. Manufacturers of metal work now know that substantiality is only one element, and that unless a second—that of ornament—be added, they stand but an unequal chance with rivals who unite both elements in the works they produce. In successful results we are apt to overlook influences; but personal observation, extending over a period of twenty-five years, leads the writer to the conclusion that the circulation of illustrated works among artisans, treating on ornament and applied design, has operated in no small degree in elevating the ornamental brass work of Birmingham to the position it occupies; and that such influence in effect is second only to that arising out of

LOAN COLLECTIONS, MUSEUMS OF OBJECTS OF ART OR INDUSTRY, AND EXHIBITIONS OF INDUSTRIAL ART,

as those held in 1851 and 1862, at the Society of Arts; in London, in 1850, and at South Kensington Museum in 1862; the reality or examination of the objects themselves being superior to even the most perfect representation by means of woodcuts, engravings, lithographs, or photographic copies. The great advance made by Birmingham in things ornamental, took its rise from the local Exhibition of Manufactures, held in a temporary building erected on the ground now occupied by the Bingley Exhibition Hall. In the year 1849, on the occasion of the visit of the British Association in that year—there for the first time Birmingham manufacturers of brass and other metal work met face to face; and as their articles were in juxta-position, they then felt their respective strength, and they learned their weakness in respect to each other. In 1851, their works were submitted to a test of a far more important character, and for the first time English metallic manufactures were tested against those of all nations who contributed to the first International Exhibition. The French, with the experience of centuries to aid them, united to the test of eleven previous Exhibitions of Industry, shone with telling force in all as regards metal work of an ornamental kind. Their familiarity with ornament of all styles—boldness of conception—delicacy of manipulation—freedom of execution—perfect knowledge of the figure—were fully shown. To English eyes there was a great originality—an originality, however, gathered from accumulated stores of ornament, garnered up in the Hotel Cluny, The Louvre, Versailles, Fontainebleau, and other treasure-houses in France. England now possesses in her South Kensington Museum more than an equivalent to the collections enshrined in the receptacles already named in France; thanks to the untiring energy and perseverance of Henry Cole, Esq., C.B.; and Birmingham, were she wise, would also have her Museum of objects, especially of best metal work. South Kensington Museum should be sacked, and its spoils distributed among the great manufacturing centres of England. Its works in gold, silver, bronze, brass, and iron, to Birmingham; its steel works to Sheffield, &c., &c. At all events, its surplus examples should be distributed, for local Museums in towns engaged in manufactures, to which the examples would be illustrative and suggestive. Art, like other mental attributes, grows with what it feeds upon. The æsthetic qualities, inherent to Frenchmen educated in the direction of manufactures, naturally turned to examples produced by the artists whom the patronage of former rulers of France had encouraged; and far from being slavish copies of old examples, modified by the modern French designer's brain, they brought forth fruit in original works, in which, while old ornament was introduced, its arrangement was changed, and it thus became an original work; it received additional beauties from the manipulative skill displayed by the artisans who worked out the ideas of the designer, and by the taste and intelligence of the manufacturer at whose suggestion the object was executed. With such works, crowds of English workmen became for the first time acquainted. They saw that with which they were not familiar, which they treasured up for after use, and which became apparent in the English metal work displayed in the Exhibition of 1862, when again means of comparison were afforded, and an opportunity occurred of testing the progress made within the eleven years which had elapsed. However, the seed sown in 1851 had not been sown by the wayside; it had fallen on good ground, and bore a thousandfold harvest. It was not only visible in specialities prepared for Exhibition purposes, but it had penetrated into things for every-day use—into cabinet brassfoundry, gas fittings, and into brass work generally; while in no particular was the substantial character of English work sacrificed, or its ornamentation impaired. Incongruities in style were more generally avoided, and an improved and progressively improving element was recognisable. Without these Exhibitions, such progress as has been made could not have been attained in the same limited time. Regarded with prejudice at first, English manufacturers looked at Exhibitions with suspicion; and it may be questioned whether without the powerful patronage and prestige of the Prince Consort, an Exhibition of Manufactures ever could have been held. That it was held is now matter of congratulation, and that a second followed and gave us the opportunity of seeing the progress made is equally so. They demonstrated the fact, that while the substantial is the natural result of the exercise of the industry of Englishmen, deeper still there lies the innate seed of that which education can also produce—the beautiful; and they showed that English designers and artisans can successfully compete with nations who have long been tacitly admitted as rulers in the empire of taste, and whose manufactures have until recently monopolised the sales in the marts of commerce all over the world. If England has succeeded as she has in introducing her manufactures of an ornamental kind into other countries, she has been enabled to do so all the earlier by and through the Exhibitions of manufactures which have been held during the last few years.

As a means of demonstrating progress, Exhibitions are unequalled, they show the position of the manufactures of the competing countries—the progressive advancement of old establishments; they introduce new establishments to public notice; display at a glance to artisans new features worthy of attention; educate the buyer, stimulate the manufacturer to increased exertion, direct attention to new modes of production, and processes until then unknown, or if known but imperfectly understood. The period has long since gone past when it was stated in reference to exhibitions of manufactures that "No body of British manufacturers would submit to be the actors in such a theatrical pageant" as a writer in the *Edinburgh Review* characterised the Paris Exposition of the year 1819. Exhibitions of works of Industry are now recognised as institutions of all countries, as such they are supported, and from such it may be questioned if any other locality has been benefitted thereby to the same extent as Birmingham. The display of the works produced there, publicly exhibited on the stalls of Exhibitions, showed to the world that these were not "lacquered shams;" and the result of each succeeding exhibition has been to demonstrate that Birmingham industry is progressive, capable of improvement, and improving; that while producing the useful, she is equally successful in the production of the ornamental. The means by which her position has been vindicated, her progress rendered strikingly apparent, and the demand for the productions of her manufactures in brass increased, are, in a great measure, owing to the publicity and to the instructive lessons afforded by Industrial Exhibitions.

BRASS MANUFACTURES AS AFFECTED BY PATENT LAWS AND THE REGISTRATION OF DESIGNS.

Recently there has been a considerable amount of opposition displayed against the operation of Patent Laws, but it is satisfactory to state that among the opponents Birmingham men are not to be found. They acknowledge the advantages of a system which has protected invention, and by that protection has stimulated and encouraged it. In no department of the great manufacturing system of this country have patents operated more beneficially than on the manipulation and chemistry of metals, and the present prosperous condition of the local brass manufacture is in no small degree attributable to Patent Law protection. In a competitive community of manufacturers a patent which confers speed in execution, superiority or cheapness of production, or a new arrangement of parts, is invaluable to the possessor, and should be equally so to the inventor, if allowed to participate, as he ought to, in the profits of his invention. Those familiar with the brass trade of Birmingham will have no difficulty in recalling to their minds not a few inventions which have largely aided in swelling the fortunes of manufacturers, and benefitted the public. Among such patents may be named the patent cased tube of Cook and Attwood, (really invented by Sir Edward Thomason); Green's solid brass locomotive tube, Muntz's sheathing metal, many inventions connected with cabinet brassfoundry, cock making, the manufacture of gas fittings, and others in connection with other departments of the brass manufacture.

In connection with the protection to inventions afforded by the Patent Laws, there is yet another form of protection by which the brass trade of Birmingham has been largely benefitted, viz.:—The Registration of Ornamental Designs. As the former Laws benefit and stimulate invention, so the Ornamental Registration Act has operated very materially in evolving ornamental designs, and in increasing the number and variety of ornamental objects in metal produced, particularly in brass. From a satisfactory source it has been ascertained that in consequence of the reduction of the fee for registration from £3 to £1, and the extension of the period of protection from three to five years, the number of registered designs have increased five-fold.

The merit of the change is due entirely to the operation of the Birmingham Chamber of Commerce.

LOCAL SCHOOL OF ART—ITS INFLUENCE.

As regards the operation of the Local School of Art on the Brassfoundry trade, while it must be admitted that the teaching of drawing and modelling are means to an end, the aid received from it has hitherto amounted chiefly to an education of the eye and hand to the appreciation of form, and the production of drawings and models, but not of an original character, or if so, unfitted, and inapplicable for practical or trade purposes. Up to the present time no leading establishment in the brass trade is *entirely* dependent upon a designer trained in the local School of Art. The Birmingham School has produced no local Godfrey Sykes; yet it would be wrong to affirm that its influence is *nil*, and it should be stated that the support it receives from the manufacturers, as a body, is exceedingly limited, and unworthy of a community dependent in a great measure on the improved ornamental character of the objects produced for sale. Anything like a real and abiding interest in the progress of the School does not appear to be felt, even by its Committee, who, selected ostensibly to direct the studies of the artisan pupils or students to practical results, virtually fail to do so, and thereby ignore the intention of the School as a means of improving the manufactures of the town. The total number of students in the Birmingham School is at present 873, of whom 190 are females, 200 pupils of King Edward's School, and 483 are students of the artisan class, or those for the benefit of whom the School was originally instituted. Of the latter number 30 are connected with the brassfoundry trade as modellers, chasers, and workmen. While, however, the direct operation of the local School of Art may appear to have exercised but little influence, the operations of its students in manufactories have no doubt largely facilitated the carrying out of designs produced by designers not trained in the School. The education of the eye leads to the correct appreciation of form, intelligence is awakened thereby, and if originality of conception has not hitherto marked the works of the students of the local School of Art, it has at least been the means o training up a superior class of artisans. The School has therefore strong claims on the manufacturers whose productions are improved thereby, directly and indirectly too.

SCIENTIFIC EDUCATION.

As regards scientific education, with the exception of the industrial classes connected with the Midland Institute, Birmingham possesses no means of educating its artisans in the *rationale* of the processes involved in the successful cultivation of science as applied to metallic industry; and no branch of manufactures would be more effectively benefitted by an infusion of science than the brass trade of Birmingham. That hitherto matters have gone on without the aid of science, simply proves that they would go on much better with it. It should not be concealed that practice and experience are in the great majority of cases at present the only guides. The laws which rule the operations in metallurgy and chemistry are only rarely, and exceptionally known, and then but partially understood by practical men. Phenomena, which occur from time to time, perplex, harass, and interfere with the progress of work. Waste is the consequence, and products are lost which might have been utilised, and increased profits would follow as a consequence of their utilisation. It is not too much to say that, up to the present time, the brass trade, as a rule, has been conducted without reference to scientific principles; that practice has hitherto been its only guide; that the little science which has been brought to bear upon it has come from without, not from within; and that a scientific education, or scientific instruction in connection therewith, would largely add to the present success of its operations. The necessity for this, though it may not be apparent to the great majority of manufacturers, is not the less needful on that account, but, nationally, it is of the utmost importance. Uneducated manufacturers and others sneer at science, because they know nothing of its value, or of the profits to be realised by its application. They forget the sources from which these came; yet science, all-bountiful, gave to Birmingham her trade in gas fittings, her solid metal tube trade, her telegraphic wire manufacture in iron, and copper, and her great industry in electro-metallurgy. "All the facilities of intercourse," said a statesman, who should have died hereafter, "are operating as bounties to skill and intelligence; they are shortening the distance between producer and consumer; and it is not safe for us to remain behind hand; for, depend upon it, if we are inferior in point of skill, knowledge, and intelligence, or general knowledge, to the manufacturers and producers of other countries, the increased facilities of intercourse will result in transferring the demand from us to others." This, spoken twenty-four years ago, is very much more applicable now, when knowledge has increased, and industrial education is embraced as an element among the recognised duties of continental states and countries, which they consider they owe to the peoples under their rule. Liebig thus clearly demonstrates the necessity for scientific education when he says, "Ordinary intelligence, with local advantages of cheap raw material, may long preserve a monopoly in special manufactures, until a competing nation, by the intelligence of her educated artisans, becomes more than equivalent to the difference in the price of the raw material. The nation most quickly promoting the intellectual development of its artisans *must*, by an inevitable law of nature, *advance*, whilst the country neglecting the industrial training must as *inevitably recede*—stationary it cannot remain. The superabundance of capital may for a time preserve a country from a quick depression, even should it lapse in its intellectual training; but the support thus given can only be temporary and illusive, for if by the purchase of foreign talent the necessary knowledge be infused into home manufactures, this has the effect of raising the intellectual element in the foreign country, and finally accelerating its success as a competing nation." At no period of the world's history was it so necessary as now, that skill and science should be wedded together for the promotion of the industrial arts; and Humbolt said truly, many years ago, that "An equal appreciation of all parts of knowledge is an especial requirement of the present epoch, in which the material wealth and the increasing prosperity of nations are in a great measure based on a more enlightened employment of natural products and forces." The only institution in the town which deals with the important element of Industrial Education is the Birmingham and Midland Institute, in connection with which there are classes for workmen, by attending which they will be largely assisted and instructed in science in connection with their special department of industry. These classes have been the means of doing much good; several of the students have gained high distinctions, and have become valuable aids in connection with manufactories. Still the number attending these classes is small as an aid to manufactures; among the seventeen students in the practical chemistry class, there is *not one* connected with the Brass Trade! But if manufacturers, as a body, are indifferent to the success of valuable institutions for the cultivation of practical or applied science, their subordinates may be pardoned if they neglect them. Yet, indifferent as manufacturers are, they spend money in purchasing inventions, which they cannot thoroughly test by their own knowledge, thus holding out in many cases a bonus to empiricism and ignorance. All the great successes in manufactures have been achieved by science, and by working on scientific principles. If a discovery has been accidentally made, and it has been successful, it has been so only because it has been in accordance with science; as such, therefore, the necessity for the study of science is of paramount importance, especially in connection with metallic industry.

ORDINARY EDUCATION IN REFERENCE TO MANUFACTURES.

Although existing schools have done good work, they do not operate efficiently in educating children of tender years who are hard worked all day in a manufactory; muscular exertion destroys mental energy for the time. The child or boy who has worked even ten-and-a-half hours is thereby unfitted to attend to or master lessons at a night school, (held frequently in an ill-aired, badly ventilated apartment); in such cases the brain refuses to act, when the muscular system is exhausted. Especially is this so with children. Though the philosopher in his study may change his subject and turn to another, the transition from the workshop to the night school of the child or boy seldom or never produces satisfactory results. Some instances may be found where even factory children in after life have acquired a very great amount of knowledge, but these are rare and exceptional cases. Every enquiry tends to show that to depend only on Night, or Sunday Schools for the education of children is to depend on what never can be alone an efficient means of Education, the elements of which should be given before the child is sent to the manufactory, and then as much as possible during the day. It is to the credit of Birmingham manufacturers, that many now acknowledge a desire to see the children, and young people employed by them, at least instructed in the rudiments of education. "I know," says one of the most intelligent of our manufacturers, in a recent discussion,* "that a considerable class of children is greatly neglected, and I join my brother manufacturers in a steady desire that our necks may be put under the yoke of the Factory Act, to remedy the evil. If notwithstanding the absence of that Act we stand as well as the best of other manufacturing towns, we may hope, with the help of it, to rise above them." The peculiar industries of the town require general as well as special education. Until the increasing and thoughtless competition is checked by some of the provisions of a Factory Act, ignorance must and will prevail, and be painfully apparent. The root of the evil, it is believed, lies in the present system of allowing workmen, more especially "piece-men and women," to employ such helps as they choose, the manufacturer seldom exercising any control whatever as to the age, education, or physical development of the boy or girl employed. Given then a compulsory rule, the abuse would be checked. It is impossible to show that legislation which is attended with beneficial results in one class of manufactures will not be beneficial in another. Manufacturers are aware that overtime working, as a rule, is not beneficial in proportion to the hours worked, or the money expended in payment thereof. "Gurth is no longer the born thrawl of Cedric the Saxon," and if we acknowledge that intelligence is God-given, the development of that intelligence by education is a duty incumbent on those who receive benefit and profit by the labours of those who are uneducated. Opposition, therefore, to the introduction of an Act which would materially aid in educating, is, to say the least, unwise. Efforts towards factory schools deserve recognition, and of these the most successful have been the school originated by the late John Fawkner Winfield, Esq., in the Cambridge Street Works, still in operation, and that connected with the works of William Tonks and Sons, both of which schools are devoted to the education of youths employed in the brass trade in the establishments named.

CONCLUDING REMARKS.

At an early period of the pleasant, and at the same time troublesome, duty of reporting on the history and condition of the Brass Trade, the writer abandoned the intention of producing a report of a purely technical character. His reason for doing so was the consideration that those engaged in the trade or manufacture treated of rarely read such reports, and to the general reader a technical report would have proved uninteresting. He has, therefore, taken the license given by the Local Industries Committee to introduce matter which he hopes will be found, as associated with the history of the branch of the trade treated of and its various processes, alike interesting and curious. The facts have grown in his hands to a length which he had not anticipated when he assented to the request of the Committee to write the report. His enquiries, however, impressed upon him the consideration that the history of a noble local industry remained to be written, the origin of its several branches traced, and the period of the introduction of these chronicled for the benefit of future historians of arts and manufactures. This he has attempted to do. The success with which this has been accomplished he leaves to the reader. Even if he has succeeded in arriving only at approximate results, he will feel satisfied, and the time consumed in collecting the information will not have been lost. If, at times, opinions have been expressed strongly, they have arisen from experience gathered over a number of years, in which he has been directly or indirectly connected with the trades described. Edmund Burke, who gave Birmingham the name of the "Toyshop of Europe," said on one occasion, "I approach the institutions of my country not with the desire to break down, but rather to substitute something which is good for what is bad, and thus to strengthen and build them up to a greater extent than at present." With similar feelings the writer has approached the brass trade. If he has pointed out wants and defects, it is that these may be supplied and remedied; from the love he bears to it, if he has indicated future results, it is because he believes that such will be attained. The period is fast approaching when scientific research will be valued and appreciated in manufactures much more than it is at present, and he who will avail himself of the results will in proportion be more successful. The future progress of the manufactures in brass is dependent on a larger employment of mechanical appliances and chemical and metallurgical knowledge. If, as regards the large proportion of female and juvenile labour employed, he has also expressed himself strongly, it is because he believes that such is calculated to operate locally, socially, and nationally, in morally and physically restraining alike the mental and physical development of the young, and in preventing the destruction of the social home-comforts of man by reducing woman from a helpmate to man and placing her in a sphere of labour for which she never was intended. Where he has recorded inventions or improvements he has, as far as possible, given the merit of these to the original inventor or improver; and he considers the large amount of prosperity and the present great extension of the trade and manufacture of brass is in no slight degree to be attributed to the total absence of trade societies and of strikes. This has consolidated the trade with no sacrifice of comfort on the part of the workmen. In all he has done, however, he has sought only the elevation of the manufacture which he has reported upon, and its future advancement.

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* Letter from Mr. William Lucas Sargant, to Lord Lyttelton, December 16th, 1865, on the Education of Birmingham, and on Commissions of Enquiry. Birmingham: Benjamin Hall.

It remains now for him to mention gratefully the assistance given him in enabling him to produce this report; and he acknowledges that to M. P. W. Boulton, Esq., of Tew Park, Oxfordshire, descendant of the truly great Matthew Boulton, and to Samuel Smiles, Esq., Author of "Self Help," "The Lives of the Engineers," and of "Boulton and Watt," he is indebted for the history of the Birmingham Brass and Spelter Company; to the proprietors of *Aris's Birmingham Gazette* for information received by the examination of early volumes of that paper; and to Dr. Percy's admirable work on Metallurgy for the early cost at which brass was made; to J. D. Weston, Esq., of Bristol, and W. H. Keates, Esq., of Liverpool, for the histories of the brass manufactures in Bristol and Cheadle; to Daniel J. Fleetwood, Esq., for his estimates of the metal consumed in the brass manufactures of this town; to Mr. Crosbie (formerly of Messrs. Alston and Green's) for information respecting the solid brass tube trade; and to other gentlemen, whose names he is not permitted to state, his thanks are also due. The thirty-two manufacturers who promptly responded to the circular of the Local Industrial Committee are also entitled to his thanks. It is to be hoped respecting those who did not reply, whether from want of time or from other motives (the "Overtaxed Manufacturer" included), that the publication of this report will show that the history and elevation of their manufactures was the only end sought. Those who declined from motives of trade secresy may be told, that if they had sent in returns no advantage could have been taken for other than the purposes of this report, as the returns were seen by the Chairman only, who gave the present writer aggregate results without the names of any of the manufacturers who made the returns, and thus the "Assessor of Taxes" was not enlightened thereby.

In conclusion, it is hoped that in future years, when the present manufacturers of brass goods are represented by their descendants, and the artisans who throng the busy workshops are replaced by others—when the hand which wields the pen with which this is written shall be at rest for ever—this report may be read and referred to, and may be regarded as a truthful history of the rise, progress, position, and extent of the local industry in Brass at the period of the Meeting of the British Association in Birmingham, in the year A.D., 1865.

THE BIRMINGHAM GUN TRADE.

By JOHN D. GOODMAN,
Chairman of the Small Arms Company, Birmingham.

From the earliest times there is little doubt but that the smiths of Birmingham were renowned for the production of swords and pikes, but it was not till the close of the 17th century that we learn, from the often quoted Mr. Hutton, that William III., at the suggestion of Sir Richard Newdegate, at that time one of the members for Warwickshire, employed certain manufacturers of the town to supply a quantity of arms for the Government service. The commission was satisfactorily executed, and, from that day to the present, the trade has increased until it has become one of the most important industries of the town. Macaulay, in his "History of England," states that in 1685 the population of Birmingham was only four thousand, and at that day nobody had heard of Birmingham guns. Previous to this time England had obtained her supplies from the Continent, doubtless chiefly from Liège. The gunmakers of Liège claim for their city the honour of being the most ancient seat of this manufacture. It is stated that in the principality of Liège it dates from the middle of the fourteenth century, when cannon, or as they were then called "bombards," were first introduced. Portable arms were, of course, of much later introduction. Previous to that date Liège had been celebrated as far back as the days of the Crusades for the manufacture of defensive armour, besides cutlasses, daggers, axes, glaives, spears, lances, poignards, &c.

Gunpowder was first known in India and China, and was probably conveyed to Europe on the return of the Crusaders. Roger Bacon, in his works published in 1267, describes its ingredients, and suggests that it might be applied to the destruction of an army or city. The composition described by him differs but very little from that in use at the present day either in the ingredients or in the proportions.

The earliest use of gunpowder for aggressive purposes was in the form of Greek fire, of which the first mention is made in 668, although the Chinese, at an earlier period, had applied it to the blasting of rocks. In the composition of Greek fire pitch and naphtha were also employed.

It is not till 1327, in the reign of Edward III., that we hear of the use of cannon, in which year he employed them in his first campaign against the Scots. At first they were formed of a tube of iron, strengthened by large iron rings, which being driven on while red hot formed by contraction a gun of great strength. It is not a little remarkable that the leading inventors of the present day should have come back to precisely the same method of building up their monster guns. The French first became acquainted with cannon when they were used against them by the English at the battle of Cressy in 1346.

Bolts and quarrels were shot from cannon in the reign of Henry V. (1413.) These were succeeded by stones. The aim appears to have been to make the guns as large as possible, and we hear of masses of stones being thrown from them weighing as much as 1,200lbs.; such guns could, however, be fired only three or four times a day. As knowledge increased, improvements were made, and the size of the cannon was reduced so as to admit of casting them in iron and bronze to receive iron bullets, which were first used in England in 1550.

Meanwhile hand-guns had been introduced. They were brought to England by Edward IV., when he landed at Ravenspur, in 1471, bringing with him 300 Flemings, armed with hand-guns. This invention dates 30 or 40 years earlier, and is attributed to the Germans.

At first the gun was a simple barrel, with an uncovered touch-hole at the top, mounted upon a straight stock, and was fired from a rest by means of a match; a few years afterwards the stock was bent, and this was shortly followed by the introduction of the match-lock.

The accidents occasioned by carrying lighted matches in near contact with gunpowder, naturally led to the attempt to produce fire at the moment it was required. This was not an easy undertaking with the limited knowledge at the disposal of our ancestors. The earliest attempt was made with a piece of pyrites, fixed opposite to the touch-hole. It required to be rubbed with a file, chained to the gun, until sparks were elicited sufficient to fire the powder.

This was a step towards the invention of the wheel-lock, which is supposed to be of Italian origin, invented about the time of Henry VIII., and continued in use until the reign of Charles II., a period of a century and a half. In the wheel-lock, the file last spoken of is substituted by a small grooved steel wheel, to the axis of which a powerful spring is attached. This, being wound up by a key, is retained in its position by a spring catch, connected with the trigger. On pulling the trigger the wheel is disengaged, and spinning round in contact with the pyrites produces the required stream of sparks.

During these periods but little alteration was produced in the art of war by the application of gunpowder. The great expense and difficulty of procuring it, added to the extreme awkwardness of the guns, both large and small, account for the preference given to the old appliances. Accordingly we find, so late as the time of Elizabeth, that the strength of our armies consisted in archers. In consequence, however, of the alarm created by the introduction of firearms, the men-at-arms at this period were so loaded with defensive clothing, that James I., when speaking in praise of armour, remarked that it not only protected the wearer but prevented him doing injury to others.

The Pistol, according to Sir James Turner, was invented at Pistoja, in Tuscany, by Camillo Vitelli, in the reign of Henry VIII. M. de la Noue says, "the Reiters first brought pistols into general use, which are very dangerous when properly managed. These Reiters, or more properly Ritters, were the German Cavalry, who gave such ascendancy to the pistol as to occasion in France, and subsequently in England, the disuse of the lance."

Bayonets were first made in 1640, at Bayonne, whence they take their name. The earliest weapons of this class were simply poignards, with wooden handles made to fit the bore of the gun. Subsequently a socket was added, by which it was fixed on the muzzle. In this way the French used it, in the reign of William III., to the astonishment of the 25th Regiment of Foot, on whom they poured a volley while halting in their charge.

The flint lock is said to be of Dutch origin; by some the invention is claimed for France. It was invented in the reign of Charles II., and was generally adopted in the early part of the reign of William III., about 1692, since which time it has continued in use, with very little essential alteration, until within the last twenty-five years. During that period, however, it had been constructed in a variety of forms.

We now come to one of the most important changes ever effected in firearms—the application of fulminating powder. Various compositions of this kind had long been known to chemists, but no one appears to have thought of applying them to the ignition of gunpowder till the Rev. Mr. Forsyth obtained a patent in 1807. The mechanical means by which he applied the use of the powder were not successful, nor did he succeed in making any improvement during the whole term of his patent. The gunmakers were all sensible that they were put on the right track, and many attempts were made to give practical effect to the invention. This was finally and effectually accomplished by the introduction of the copper cap in 1816. The name of its inventor is not known; no patent was taken out, as that of Mr. Forsyth was in force at the time. Mr. Joseph Egg is said to have been the first to introduce it.

The percussion cap has now held its ground for fifty years, with little or no change. At the present moment it is in danger of being superseded, as breech-loading with cartridges carrying their own ignition is fast taking its place.

The percussion principle first introduced in 1807, made practicable, although perhaps not perfected in 1816, was not used in the English military service till 1839.

The French did not move faster than we did; for it was not till 1840 that a grant was made by their Government for altering 700,000 flint to percussion guns.

Our attention has hitherto been directed to improvements having for their object the best mode of discharging the gun; we now come to speak of those which relate to its accuracy as a weapon of precision. The use of rifled barrels is by no means a modern invention. Barrels were first grooved by the Germans at the close of the fifteenth century. The name of Gaspard Zollner, of Vienna, is handed down as having made one of the earliest specimens. At first the grooves were straight, the object being probably to diminish the friction of the bullet. In 1620, Koster, of Nuremburg, gave a spiral direction to the grooves, with a view of giving the ball a rotary motion. The rifle was soon introduced into the military service, as we find the Poles shortly afterwards making use of them for the defence of ramparts; and during the succeeding century several of the Continental powers armed some of their soldiers with them, but it was not till 1794, during the American War, that they were introduced into the English service. The extreme difficulty of loading the rifle, when the ball, encased in a patch of leather, had to be driven into the barrel with great force, prevented its extended use, until within the last fifteen years, when the difficulty referred to was overcome by the substitution of bullets which expand in firing, and which consequently do not require to fit the barrel closely in loading. This is the system adopted in the Enfield rifle now in use in the English service. A short review of the progressive steps which have led to this improvement may not be uninteresting. So far back as 1826, M. Delvigne, a French officer, proposed to use a loosely fitting spherical ball, which, while in the barrel, should be swelled out by a few blows with the ramrod. The result was not satisfactory, the ball was beaten into an irregular form, and accuracy of flight was destroyed. This led, however, to further experiments in the same direction. In 1836, Mr. Greener, of Birmingham, suggested an expansive bullet. He constructed a ball of lead with an opening into which a plug of some harder metal was driven by the explosion of the powder so as to expand it; in this case also a projectile of irregular form was the result. Meanwhile the French were not idle. In 1844, Colonel Thouvenin produced the well-known carbine of the Chasseurs of Vincennes, called also the carabine-à-tige, in which a steel pin, or tige, is placed at the bottom of the barrel, of sufficient length to stand above the powder; on this the projectile, to which an elongated form had been now given, was expanded by a few smart blows of the ramrod. This arm proved practically serviceable, the range and accuracy accomplished by it far exceeded what had been hitherto attained. In 1849, Captain Minié effected the further improvement which has made the rifle what, in its essential points, it now is. He removed the tige, which on many grounds was found objectionable, and, for the bullet previously used, he substituted one hollow at the back; its expansion is accomplished by the explosion. Captain Minié placed an iron cap in the hollow with a view of assisting the expansion; the use of this has since been abandoned. In the English service a plug of box wood is substituted.

It was at this period that our Government first gave their serious attention to this arm, and in 1851 it was introduced into our service. The first rifle was found too heavy, and in 1853 a committee of military officers, appointed by Lord Hardinge (at that time Secretary of State for War), was instructed to devise a more suitable model—the rifle now in use throughout the English service, known as the Enfield rifle, being the result of that enquiry.

Subsequent inventors, at the head of whom stands Mr. Whitworth, have directed their attention to obtaining increased range and greater accuracy by means of improvements in the form and character of the rifling, and also in the ammunition. The great success attained by Mr. Whitworth is well known, and his system will be found more or less embodied in the greater number of the recent improvements which have succeeded his. It has now been decided that in future the English army shall be provided with breech-loading guns. At present no one system has been absolutely selected as the best, and an ample field is therefore open to inventors.

It should be mentioned, however, that the breech-loader of Mr. Westley Richards has now for some time been in use in the service, on an experimental scale, and has been tested in the field, both in China and in New Zealand. The experience thus gained of this arm has induced the Government to extend its use, and at the present time a large number for the cavalry service is being manufactured by Mr. Richards, and at Enfield.

In 1861, a thousand breech-loading carbines were made in Birmingham for our cavalry, on Terry's principle. The experience of this arm has not led to a more extended use of it in the English service.

The position in which the question now stands will be gathered from the following concluding remarks, taken from the Report of the Committee (March 14, 1865) appointed by Government, on the trials at Woolwich of Enfield rifles converted to breech loaders.

The Report, after speaking of the obvious disadvantages which a breech-loader requiring a cap presents, when contrasted with one adapted for a cartridge carrying its own ignition, proceeds to say:—

> The Committee have now respectfully to submit their observations on the whole question.
>
> The ultimate armament of the infantry with breech-loading weapons is determined upon. It would be done at a comparatively small cost by conversion; but it is now well known that the calibre, twist, and form of rifling of the "Enfield" is not the most favourable for fine shooting, and it is quite certain that no converted arms can possess the precision which will be easily attained in a new breech-loader of smaller gauge and quicker twist. Nor will the soldier be able to carry that increased quantity of ammunition which is so desirable, without a reduction of calibre.
>
> If, under these circumstances, and notwithstanding the great outlay which will attend it, the Government adhere to the decision to introduce a new small-bore breech-loader, as soon as there is a pattern ready, the Committee do not think it desirable to proceed at present with conversion on a large scale; but as there are purposes which may be answered by the converted arms, and as the

experience to be acquired by the conversion may have some bearing on the larger question, they recommend that Mr. Snider be encouraged to pursue his experiments by the promise that, on the production of a pattern arm which shall give satisfaction to the Committee, 1,000 muskets (or enough to arm one battalion) shall be placed in his hands for conversion.

The extension of the operation should depend upon the success of the experiments about to be entered upon with the new small-bore weapons, the probability of their early introduction, and the reports of the battalion or battalions, to which the converted arms may be issued.

There are certain circumstances in which, notwithstanding all the inconveniences which will attend the co-existence of unaltered arms, converted arms, and new arms, with their different ammunitions, it may still be desirable to proceed with the conversion on the ground of its small cost, and of the less time in which the arms can be turned out, but the Committee do not feel in a position at present to recommend such a measure.

J. H. Lefroy,
Brigadier-General, R.A., President.

Snider's system is thus described in the Report:—

This is a new system, and dispenses with the nipple and percussion cap, being adapted for a cartridge carrying its own ignition.

The method of conversion is very simple. About two inches of the upper part of the Enfield barrel are cut away at the breech, and a solid breech stopper working sideways on a hinge is placed in the opening thus made. A piston passes through the stopper, and when the breech is closed one end of it receives the blow from the hammer, and the other communicates it to the centre of the cartridge and fires it.

There is an arrangement for withdrawing the old cartridge cases after each discharge.

Sporting guns, on the breech-loading principle, are in very general use, and there are many systems which offer all the advantages desired. The production of an arm suitable for military use is attended with much greater difficulty. Points have to be considered which in a sporting gun are comparatively unimportant. It is indispensable that the arm should be safe, certain of action, strong, and durable, and this, under all conditions of climate, and exposure to every kind of weather—the cartridges must possess the same qualities in order that they may be fitted for conveyance to distant parts, without fear of accident, or injury by damp or breakage; and as it is now generally considered that the cartridge should carry its own priming, in order that the capping may be dispensed with, these conditions are not so easy of accomplishment as may at first sight appear.

SYSTEM OF MANUFACTURE.

Having now slightly sketched the history of guns from their introduction to the present date, we proceed to speak of the manufacture as conducted in this town.

The manufacture of the various parts of the gun, as barrel, lock, &c., are distinct trades. These several parts are collected by the manufacturer, known as the gunmaker, and by him are set up.

The chief branches are as follow:—Stock, barrel, lock, furniture, and oddwork making; and for military guns there are in addition,—bayonet, sight, and rammer making. The stocks are of two kinds, beech-wood and walnut. The former is employed for African markets, and for the lower description of sporting guns; its liability to expand and shrink with changes of the atmosphere unfits it for any but guns of the cheapest description.

The stocks are brought to Birmingham, cut from the plank into the form of the gun. Beech-stocks are grown in this country, chiefly in Gloucestershire and Herefordshire. Walnut-wood is free from the objection to which beech is liable; ash and maple are occasionally used, but they are very difficult to work. Walnut stocks are, with few exceptions, imported from Italy and Germany. One Birmingham contractor, to meet the demand occasioned by the Crimean war, established sawing mills in Turin, and since that period has converted into gun stocks nearly one hundred thousand walnut trees. He has left but few sound trees standing in the district in which he carried on his operations. The greater part of the supply was obtained in Piedmont, and smaller quantities from Ferrara, Bologna, and Modena. It is found that the timber grown in the plains is superior to that in the mountainous districts, the former being tougher and closer grained. An average-sized tree yields about thirty gun stocks; those cut from the heart of the tree are the most valued, and are used for first-class military arms and the best sporting guns; about one stock in five or six can be obtained "all heart," the remainder are "sap and heart," and "sap."

Barrel making is quite a distinct trade. For the manufacture of military barrels, a somewhat large plant of rolling, boring, and grinding machinery is required. No barrels are made in England, except in Birmingham, and its immediate neighbourhood.

Military barrels are made, in the first stage, by the process of rolling. A slab of iron 12 × 5½ inches, and ½ inch thick, is first turned in a pair of grooved rolls, until the edges meet. It is then brought to a welding heat and closed in a third groove of the roll. It is subsequently heated again, and passed through a succession of grooves on a mandril, until the 12-inch tube is drawn out to the required length of about 40 inches.

The invention of making gun barrels by means of grooved rolls is due to a Birmingham manufacturer of the name of Osborne. It was on the occasion of a strike of the barrel welders that he was led to make the experiment. He was not allowed to introduce his system without opposition, for no sooner were his rolls set to work than twelve hundred barrel welders, each armed with his forge hammer, proceeded to the private residence of Mr. Osborne, in the Stratford Road, threatening its destruction. The military were called out before the disturbance could be quelled, and for many days afterwards a guard was placed over the mill in which the work was carried on.

The iron of which military barrels are made is specially prepared for the purpose, with the utmost care, in order to obtain a quality which shall possess great strength, shall be perfectly homogeneous, and entirely free, when worked, from flaws or specks. The cost of this iron is, at the present time, nearly three-fold that of ordinary bar iron.

Evidence of the suitability of this material to the purpose is given in the fact that the number of barrels made for the English service, which burst in proof, is found not to exceed two barrels in a thousand a greater number than this is, however, rejected for flaws, as a barrel is condemned as unfit for service, if a speck, discernable only to the practised eye of an expert, is found on any part of the barrel, either outside or inside.

The difficulty of obtaining in other countries iron of this high quality, has led to the use of steel for rifle barrels; this is the case at the present time in America, Austria, and Prussia. The subject is under consideration in England, as steel, in addition to being equally free from flaws as our iron, is harder, and a rifle barrel made of it is less liable to injury from a fall or blow; this is an important consideration when it is borne in mind that the slightest indentation or bend in the barrel will spoil the accuracy of the shooting.

When steel is used the process of manufacture is somewhat different; a solid bar of steel is tilted to the required size, and the bore afterwards drilled out.

The process of rolling is also employed for the common barrels, used in the manufacture of cheap sporting guns, and African muskets. For such barrels a low quality of iron is used, and they can be produced very cheaply. Barrels for the better kinds of sporting guns are forged by hand on the anvil. They are twisted in various ways known as "plain twist," "stub twist," and "Damascus," &c. Twisted barrels are made by winding on a mandril a band of iron which is afterwards welded on an anvil; the pattern or figure of the iron is brought out by the application of aids in the process known as browning. The plain iron barrels of common guns are stained to imitate the pattern of the twist.

Gun Locks are made in Birmingham, and, on a still larger scale, in the neighbouring towns of Darlaston and Wednesbury. One maker (Joseph Brazier), whose work attained the highest celebrity, until recently carried on the manufacture at Wolverhampton. He is now dead, and the works are no longer continued.

Till within the last few years locks were entirely the production of hand labour, the several parts were forged on the anvil by men whose wonderful skill became proverbial. They were afterwards put together by filers, to be finished by the polisher and hardener. At the present time the steam hammer and stamp are superseding the forge, and milling machinery is doing much of the filer's work, but in no case, even when machinery is carried to the highest perfection, can the filer be dispensed with; the locks cannot be put together until all the limbs have passed through his hands to receive the final adjustment.

Furniture, under which head are included the heel-plate, trigger-guard, &c., is made either of brass for military guns, or of cast iron for common sporting guns, or forged iron for the better qualities, all of which have to be filed and polished, and in the case of iron furniture it has also to be blued or hardened. This trade is carried on in Birmingham.

The Oddwork, consisting of screws, pins, swivels, &c., is produced in Birmingham by manufacturers who make also sundry implements connected with the trade, such as turnscrews, nipple keys, lock vices, &c.

The bayonets required for the military trade form an important branch. They are made in Birmingham and West Bromwich; the blades are of steel and the sockets of iron.*

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* Morfitt, writing in 1802, states that "previous to making swords for the public use, Birmingham was celebrated for its bayonets: the first Government contract for the former was given to the late Mr. S. Dawes, of Snow Hill, and the late Mr. Hervey; and both these important articles are now, almost exclusively, supplied from hence, to the great emolument of the town and of the public; for the blades of Birmingham, like the hearts of British warriors, will never fail."—(J. Morfitt's Sketch of Birmingham in Pratt's "Harvest Home," 1806.—EDITOR.

The required form is given to the blades either by forging or by rolling with grooved rolls; they are afterwards ground, polished, and hardened, and the socket filed and finished.

The sword bayonet, which has been largely adopted, is generally produced by the same manufacturers.

Scabbard making is a distinct branch; scabbards are of two kinds, steel and leather.

The sight required for the present military rifle calls for high skill in its production. It is made, as in the case of locks, by stamping, milling, and filing. The manufacture is a branch which usually accompanies lock making, as it employs the same class of hands.

Military rammers, which are of steel, require machinery for rolling, grinding, and polishing. They are made in Birmingham and West Bromwich by manufacturers who combine with it other branches of the trade, as bayonet and implement making.

On reference to the Directory of the present year we find 599 names of manufacturers engaged in the different branches of the trade. Among these are enumerated :—

Gun makers	171
Barrel makers	32
Furniture makers	23
Lock makers	25
Nipple makers	3
Implement makers	61
Case makers	11
Wadding makers	5

Of the remainder the greater number are makers of different minor parts of the gun. Others again are workmen, such as stockers, finishers, engravers, &c. These last are of the class who are outworkers, employing a few assistants, and working, at the same time, for different masters.

Gunmaking, or setting-up, is again much subdivided. It is only in the more important establishments that all the branches are carried on on the premises of the gunmaker. More or less, outworkers are engaged in every branch. This system makes it extremely difficult to obtain a correct estimate of the number of workmen employed in the trade. Probably no master can tell how many hands he is employing at any given time, and the number varies, from month to month, with the demand. About ten years ago an endeavour was made to ascertain the number of hands employed, and, as the workmen themselves assisted in the enquiry, it was at the time, no doubt, a tolerably correct estimate. The number is now larger, and probably it does not represent more than half the number called into requisition by the American demand during the war.

The following list will at once show the branches into which the work is subdivided, and the approximate number engaged in each.

With trifling exceptions, women are employed only in one branch, that of "making-off," or giving the final sand-papering and polish to the stocks; a light and not unsuitable employment. A few women are employed in polishing and barrel-boring. It is difficult to say why such work has fallen into their hands, as it is both dirty and laborious.

CLASSIFIED LIST OF WORKMEN EMPLOYED IN THE GUN TRADE, WITH THE ESTIMATED NUMBER IN EACH BRANCH.

MATERIAL MAKERS.

Stock Makers	100
Barrel Welders	700
,, Borers	
,, Grinders	
,, Filers and Breechers	
,, Rib Makers	
,, Breech Forgers and Stampers	
Lock Forgers	1,200
Machiners	
Filers	
Furniture Forgers and Casters	100
Filers	
Rod Forgers	100
Grinders and Polishers	
Finishers	
Bayonet Forgers	500
Socket Stampers	
Ring ,,	
Grinders and Polishers	
Machiners	
Hardeners	
Filers	
Band Forgers and Stampers	300
Machiners	
Filers	
Pin Makers	
Sight Stampers	300
Machiners	
Jointers	
Filers	
Trigger Boxers	20
Oddwork Makers	100
	3,420

SETTERS-UP.

Machiners—Prepare the front sight and the lump end of the barrel for the nipple	50
Jiggers—Lump Filers and Break-off Fitters—Prepare the breech end of the barrel	200
Stockers—Let in the barrel and locks, and roughly shape the stock	1,000
Percussioners—Finish the nipple seat, put in the nipple, and adjust the hammer to the nipple	200
Screwers—Let in the furniture, and all the remaining pins and screws	1,000
Strippers—Prepare the gun for rifling and proof	20
Barrel Borers	50
„ Riflers	50
Sighters and Sight Adjusters	50
Smoothers—Prepare the barrel for browning	100
Finishers—Distribute the several parts to browner, polisher, maker-off, and barrel smoother, and when they are returned put the guns together, and finally adjust the several parts.	1,000
Makers-off—File the stocks to give them their proper finish; glass paper and oil them	
Polishers—Lock and Furniture	50
Engravers (Lock, &c.)	50
Browners (Barrel)	50
Lock Freers—Finally adjust the working parts of the lock	50
	3,920

Summary.—Material Makers	3,420	
Setters-up	3,920	
Total		7,340

The outworking system leads to the employment of a considerable number of young boys, who are employed mainly in carrying the work from one to another, as it passes through its several stages; we regret to say that many are employed in this work too young for the burdens they are called upon to bear. At any time, in the neighbourhood of St. Mary's Church, in which district of the town the gun trade has located itself, the lads may be seen, one with half-a-dozen stocked guns on his shoulder, conveying them from the stocker to the screwer; another with a tray full of locks for the polisher; a third on his way with a few barrels to the Proof-house, and so on.

WAGES.

No very correct estimate can be given of the rate of wages earned by the workmen in the gun trade. With very few exceptions the work is paid for by the piece, and the rate varies considerably with the demand. During the past ten years there is little doubt but that the wages earned in this trade have probably exceeded those in any other. Several branches require very high skill, and the remuneration is in proportion; for instance, barrel boring and setting, stocking, rifling, lock filing, &c. A judgment can be formed of the delicacy of workmanship required in the first of these branches, when it is understood that a military barrel has to be bored with such truth that it must receive a plug measuring 577-thousandths of an inch, and is condemned as useless if it takes one of 580. A workman in this branch, with full employment, has frequently been known to earn his £5 to £6 a week.

The process of "setting" a barrel, that is straightening it, is another branch calling for the very highest skill. It must be understood that the degree of straightness required in a gun barrel is nothing short of absolute perfection. The practised eye of a barrel setter can detect a deviation from the straight line which no mechanical contrivance can discover. He accomplishes his object by looking through the barrel, while standing in front of a window, and causing the shade of the upper edge of the window to traverse up and down the tube. The irregularities in the outline of the shade show him where the inaccuracies exist. These he removes by well directed blows of a hammer, the perfecting blows being given with a light wooden mallet.*

It is a very common practice, in many of the branches, for a workman to employ several assistants, whether working in the factory of his employer, or as an outworker; such men, while paying those under them at the rate of 5*s*. to 10*s*. for boys, and 15*s*. to 25*s*. to adults, per week, will take for their own share several pounds. A workman is held to be an inferior hand, who, in any of the skilled branches cannot earn, single-handed, 30*s*. per week. It must be admitted that in many cases these high wages confer little benefit, the money is frequently wasted, and bad habits encouraged, but on the other hand, many are known to have saved money. Workmen, in this trade, will be found enrolled in one or other of the freehold land societies of this town, and living in houses of their own. The recent Bank failure, in Birmingham, discovered savings which were little known before; in one case a screwer, who had steadily remained in the employment of one master for twenty-five years, was found to have no less than £800 lying in the Bank.

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* We learn from a MSS account of the gun manufacture, written by Mr. Hawkes Smith some thirty years ago, which has been kindly placed in our hands by Mr. Toulmin Smith, that this mode of testing the accuracy of the inside of a barrel was the discovery of a Birmingham workman (a fine borer) forty or fifty years before. The discovery, which Mr. Smith very justly estimates as worth many thousand pounds, was sold by the short-sighted discoverer for five guineas and a pot of ale.

Strikes have occurred in the gun trade, but happily, not frequently. The gunmakers engaged in the military arms trade are associated together—one object being the regulation of wages to be paid to workmen. The men, in like manner, act together; the respective leading branches having their own organisation. Masters and men each know the strength of the other, and have, on the whole, so arranged their mutual dealings as to avoid disputes.

A serious strike occurred in 1859, which lasted nine weeks, it was finally settled by arbitration. With that exception, during the last ten years, but few difficulties have occurred.

The Birmingham workmen are much more highly paid than those of Belgium and France. We find it stated in evidence given by French gunmakers before a Government Commission, appointed to enquire into the state of the gun trade of France in 1860, that the average earnings of the French workmen were 3*fr.* to 3*fr.* 50*c.* per day, or 14*s.* 3*d.* to 16*s.* 7*d.* per week. The same witnesses stated that in Liège the average earnings were 2*fr.* 50*c.* per day, or 12*s.* per week, but they included the earnings of women and children, and as they were seeking protection for their own industry, were probably disposed to underrate the wages paid by their Liège competitors. A deputation of London and Birmingham gunmakers, who visited Liège in 1856, reported that in the military trade of that city the average earnings of the men were about 25*fr.* a week; there were some instances of men earning 8 to 10*fr.* a day, but they were told that such cases were rare.

This deputation enquired into the system pursued between the Belgian gunmakers and their workmen—they found the work less subdivided than with us. The report goes on to say,—

> The gunmaker deals only with two men, who stock, screw, finish, make-off, and polish the gun; these men were held responsible for the work to a greater extent than with us, should any fault be found the men are called upon at their own cost to replace the defective part. The workman receives no pay until the guns have passed view. In case of rejection for fault in any one particular, both workmen lose their pay. The workman usually lives in the country, at various distances, some as far as eight or nine miles away. They are generally steady, tractable, and very willing to be taught; they are close copyists, and work very accurately. Drunkenness is comparatively little known amongst them, and they work steadily every day in the week, and even during a portion of the Sundays; but on certain Saints' days, which are numerous, they give themselves relaxation. The whole of the gun is made by hand labour, no

attempt having been made to introduce machinery, not even for the percussioning of the lump. With two or three exceptions, there are no gun manufactories, properly so called, in Liège.

In a report by Mr. Barron, her Majesty's Secretary of Legation, on the Arms Trade of Belgium, presented to the Houses of Parliament in June last, we read the following account of the Belgian workmen:—

> The stocker and setter-up come to the counting-house with their wives and apprentices to fetch their pieces of work, thus losing a day on the journey and at the tavern. Women are constantly seen in the streets of Liège carrying bundles of gun barrels on their heads. The guns come back to the manufacturer after six or seven months. The setter-up brings twenty or twenty-five at a time. Another loss of two or three days occurs in viewing these arms. Two or three guns will be rejected, and this loss will fall on the workman, who is probably in debt, having been so long without receiving any wages. The wages of several months' labour are paid to him at once, exposing him to temptation and robbery. It is not surprising if these two classes live in a state of chronic pauperism. They are generally ill-lodged, ill-provided with tools, and stinted of air and space. It is common to see a stocker or a setter-up obliged to work and sleep in the same room, surrounded with a family, and perhaps a hundred guns.

The facts stated in these reports point out the advantage possessed by our Belgian rivals in the very low-priced labour at their command. On the other hand, the better paid, and better fed English workman can accomplish an amount of work considerably in advance of his Belgian workfellow; and the English manufacturer possesses a further advantage in the more extended application of machinery, the use of which in Liège is discouraged by the cheap rate at which hand labour can be obtained.

GUN MAKING BY MACHINERY.

The Birmingham gunmakers, anxious to maintain their position, have long been aware that a more extensive use must be made of the advantages which they do possess, and this has led to the erection in Birmingham of an establishment for the manufacture of guns by machinery, on the interchangeable principle. We must give America credit for the introduction of this system. It was from thence that it was brought into this country. The attention of the English Government was first called to the subject by a Commission, of which Mr. Whitworth and Mr. George Wallis, late Head-master of the Birmingham School of Art, were members. They visited the United States in the summer of 1853, for the purpose of inspecting the New York Exhibition, and while there they extended their enquiries by visiting several establishments, among others the Government Arms' Factory, at Springfield. Their report induced the Government to determine on the establishment of a manufactory at Enfield, on the same system as that pursued at Springfield.

Before this resolution was carried out the subject was warmly debated in the House of Commons, Mr. Newdegate, Mr. Muntz, Mr. Geach, Lord Seymour, and other members strongly insisted on the impolicy of Government entering into competition as manufacturers with the private trade of the country, and it was agreed that a committee should be appointed "to consider the cheapest, most expeditious, and most efficient mode of providing small arms for her Majesty's service." An opportunity was afforded to the gunmakers to give evidence. The result was that the Committee recommended that the factory should be carried out only on a modified scale. The breaking out of the Crimean war shortly afterwards, however, led to this recommendation being disregarded, and the factory at Enfield was erected on a scale even larger than that originally contemplated.

A second Commission was sent over to the United States, with instructions to inspect the different gun factories in that country, and to purchase such machinery and models as might be found necessary for the proposed factory at Enfield.

The Commission consisted of Colonel Burn, Royal Artillery; Captain Warlow, Royal Artillery; and Mr. Anderson, the Ordnance Inspector of Machinery. They spent several months in visiting the States' Armouries of Springfield and Harper's Ferry, and also a large number of private manufactories of various descriptions wherever labour-saving machinery was employed offering any novelty.

Their report says,—

> In consequence of the scarcity and high price of labour in the United States, and the extreme desire manifested by masters and workmen to adopt all labour-saving appliances, from the conviction of such being for their mutual interest, a considerable number of different trades are carried on in the same way as the cotton manufacture of England, viz.: in large factories, with machinery applied to almost every process, the extreme subdivision of labour, and all reduced to an almost perfect system of manufacture. As regards the class of machinery usually employed by engineers and machine makers, they are, upon the whole, behind those of England; but in the adaptation of special apparatus to a single operation in almost all branches of industry, the Americans display an amount of ingenuity, combined with undaunted energy, which, as a nation, we would do well to imitate, if we mean to hold our present position in the great market of the world.
>
> Among the many branches of trade to which these remarks apply, that of small arms stands conspicuous.

The manufacture of small arms by machinery owes its origin to the invention of a lathe for cutting irregular forms, which is due to an American of the name of Blanshard, a machine which the Commission found had been used very extensively for about thirty years in the turning of shoe lasts, boot trees, oars, spokes of wheels, gun stocks, &c.

It may be said to consist of two lathes placed side by side, the one containing a copy of the object required, and the other the material out of which it is to be made.

The sliding rest which holds the turning tool also carries, in contact with the copy, a dumb-tracer of the same form as the turning instrument.

The turning instrument is a wheel containing a series of rounded cutters, which revolve at 3,000 to 4,000 revolutions per minute, while the material and copy turn together slowly. The dumb-tracer is also a round-edged wheel, turning freely on its axis, a weight is employed to pull this tracer into contact with the copy, so that as the copy turns round, this tracer moves in and out according to the form of the copy, and as the material to be turned has the same motion as the copy, and the turning instrument the same as the tracer, it of course produces a shape the same as the copy, and by sliding the rest slowly down the double lathe, the article is completed.

This machine was first used in the Springfield armoury about twenty-five years ago. It serves to give only the external form to the stock; it was a work of time before other kinds of machines were perfected, which were required for the subsequent processes of letting in the lock, guard, &c. This work is done in a series of machines in each of which is an exact copy, in hardened steel, of the part to be cut. We will suppose it is the recess required for the lock, the stock is laid alongside this steel copy, above is a frame carrying revolving cutters with tracing, or guide pins adjusted to them of the same size as the cutters; the guide-pin is brought in contact with the steel copy, and while being traced over it, the corresponding cutting tool, in contact with the wood, cuts out an exact counterpart of the copy. It was by machinery of this class, patented by Mr. Jordan, that much of the carving for the Houses of Parliament was executed.

At first the barrel, locks, and other metal parts of the gun were made by hand labour, and let into the stocks thus prepared. By degrees, machinery was applied also to the metal work, until, as at the present time, the entire work is accomplished by it. Almost every part, however, still requires the hand labour of the file to remove burs, and the marks of the cutting tools, as in like manner the wood stock has to be sand-papered and finished off previous to being oiled, and made ready to receive the several parts of the gun.

The first consideration in preparing the ironwork to be operated upon by the machines, is to have the pieces uniform in size; this necessitates the substitution of stamps and dies for the preparation of the parts, which previously were forged on the anvil.

The instrument most used in cutting the ironwork of guns is the circular milling tool. These "mills" are used of every variety of form according to the form to be cut, and the machines in which they are applied are variously constructed.

In the most common arrangement of milling machines a headstock carries a running spindle, which can be raised or lowered to modify the thickness of the article to be cut; and in those where a heavy cut has to be taken, or where the spindle and cutters would overhang the headstock too far, a second or steadying headstock is used, which is also adjustable. Under the spindle, a vice or holder, to suit the shape of the article, is secured to a self-acting slide-rest, so that by fixing a piece of iron to be worked upon in the vice, and having mills on the spindle of the shape required, and passing the former under the latter, the same form will be cut in every case so long as the mill retains its shape.

One of the chief points to be attended to, is the keeping such tools permanently up to the original form; for if there is any departure, however small, the several parts will not interchange.

When holes have to be drilled in an article, as in the lock-plate, for example, it is enclosed in a perfectly fitting steel box, having a lid provided with holes corresponding with those required; the drilling machine contains a number of spindles, each carrying a drill of the required size, and running at the proper speed. These drills in succession are passed through the respective holes in the lid of the case, at the same time piercing the soft article which it contains; thus, perfect identity and absolute accuracy are obtained, and, as each machine is used for a single operation only, that operation is thereby rendered extremely simple, and requires but a small amount of care or skill in its performance.

A very important class of machinery called "edging machines" is much used. They are employed to trace irregular figures, and to impart an exact outline. For example, it is absolutely necessary that every lock-plate should be exactly alike on the edge that fits against the wood of the stock. This rigid degree of accuracy is produced by the "edging machine."

The lock-plate, after being milled close to the edge by a milling machine, is fixed on a frame, in a definite position with regard to its several holes, &c. By its side is a steel copy of its true shape; above the two there is a sliding frame which carries two spindles both of the same size, except that one revolves and cuts, and the other is dumb. The dumb spindle moves in contact with the copy, thus causing the cutting one to move in contact with the lock-plate, and making it precisely the same in outline as the pattern.

No change has been made in the mode of conducting the finishing processes, such as rifling the barrel, polishing the furniture, browning the barrel, &c.

It will be seen that the mode of manufacture now described is applicable to the production of every description of guns, provided the quantity required of any one model be large.

This description of the means used to accomplish the end must only be regarded as a very slight sketch. It would be wearisome were an attempt made to describe in detail the great variety of processes employed to produce the sixty-two or three several parts which constitute the gun. It will be sufficient to say that the total number of processes which an Enfield musket of the pattern 1853 undergoes is upwards of 600.

To return to the question of interchange, a more apt illustration of the result produced cannot be given than by quoting from the Report of the American Commission the account of their examination of the American guns. Improvements have been made since that time in the direction of producing a higher standard of close fitting, as the English authorities were not satisfied with the American standard in this respect. Very little change has been made in the description of machines used, although of course many little improvements and modifications have been introduced.

The Report says:—

> With regard to the interchange of parts between the machine-made muskets of the United States Government, which has caused so much discussion, the Committee particularly interested themselves; and with the view of testing this as fully as possible selected, with Colonel Ripley's permission, ten muskets, each made in a different year, viz., from 1844 to 1853 inclusive, from the principal Arsenal at Springfield, which they caused to be taken to pieces in their presence and the parts placed in a row of boxes mixed up together. They then requested the workman, whose duty it is to "assemble" the arms, to put them together,

which he did, the Committee handing him the parts taken at hazard, with the use of a turnscrew only, and as quickly as though they had been English muskets, whose parts had carefully been kept separate.

The only part of the musket bearing any mark being the barrel and lock, which are stamped with the year in which they were made, and all these tried being of different years, the Committee took care that no barrel and lock bearing the same date should come together again, and they were put together as follows viz.:—

The barrel of	1847	with the lock of	1849
,,	1844	,,	1852
,,	1846	,,	1848
,,	1845	,,	1844
,,	1851	,,	1850
,,	1848	,,	1853
,,	1849	,,	1845
,,	1852	,,	1847
,,	1850	,,	1851
,,	1853	,,	1846

The other parts having no distinguishing marks were handed out at hazard.

With regard to the fitting of these muskets when thus interchanged, the Committee are of opinion that all the parts were as close, and the muskets as efficient, as they were before the interchange took place.

The experiment of interchanging was also tried on three locks with the most perfect success, the parts fitting as closely and working as freely after as before the interchange had taken place.

The concluding remarks of this report afford such admirable suggestions that it is hoped no apology is needed for their insertion here, particularly when it is borne in mind that the observations were chiefly derived from an examination of Gun Factories and kindred establishments.

One distinguishing feature of manufacturing establishments in the United States, both public and private, is the ample provision of workshop room in proportion to the work therein carried on, arising in some measure from the foresight and speculative character of the proprietors, who are anxious thus to secure the capabilities for future extension, and in a greater degree with a view to securing order and systematic arrangements in the manufacture.

Another striking feature is the admirable system everywhere adopted, even in those branches of trade which are not usually considered of much importance; this applies not only to the selection and adaptation of tools and machinery, and to the progress of the material through the manufactory, but also to the discipline and sobriety of the employed.

The contriving and making of machinery has become so common in this country, and so many heads and hands are at work with extraordinary energy, that, unless the example is followed at home, notwithstanding the difference of wages, it is to be feared that American manufacturers will before long become exporters, not only to foreign countries, but even to England; and, should this occur, the blame must fall on the manufacturers of England, for their want of energy in improving their machinery and applying it to special purposes. The advantages, in a manufacturing point of view, are all on the side of our countrymen, and there is nothing made in which they ought not to be able to undersell their American competitors either in England or on the Continent.

Another point, bearing on this important subject, is the dissatisfaction frequently expressed in America with regard to present attainment in the manufacture and application of labour-saving machinery, and the avidity with which any new idea is laid hold of and improved upon—a spirit occasionally carried to excess, but upon the whole productive of more good than evil.

The care almost universally bestowed on the comfort of the workpeople particularly attracted the notice of the Committee; clean places for washing being provided, presses to contain their change of clothes, and an abundant supply of good drinking water, in many cases cooled with ice.

The Committee also remarked with satisfaction the regular attendance and cleanliness of the workmen, and the rigid exactness with which the work is continued up to the last minute of the working hours.

A remarkable feature in the character of the native American workmen is their sobriety; water is their usual beverage, and this they use inordinately in hot weather, but rarely anything stronger; clear-headedness results from this, and gives them a powerful advantage over those who indulge in stronger potations, which will eventually produce its effect on the national manufactures, as it now does on the intelligence and character of the individual workman.

ENGLISH GOVERNMENT FACTORY.

On the return of this Commission from the United States, the works of Enfield were pursued with vigour, accelerated by the breaking out of the Crimean war. The works were commenced in 1854, and the first guns were produced in 1858. At this time the annual returns made to the House of Commons show that the sums expended amounted to £352,583, divided as follows:—

TOTAL SUM EXPENDED AT ENFIELD FACTORY, FROM THE 1ST DAY OF JANUARY, 1854, TO 31ST DAY OF MARCH, 1858.

Buildings	£91,618
Machinery	68,653
Stores	48,692
Salaries	7,048
Wages	135,182
Miscellaneous	1,440
	£352,583

The producing power of Enfield was arranged for the manufacture of 2,000 guns per week. The number annually made is shown by the following returns:—

NUMBER OF INTERCHANGEABLE RIFLES MANUFACTURED AT ENFIELD IN EACH OF THE FOLLOWING YEARS,—

To 31st March, 1858	26,739
" 1859	57 256
" 1860	87,405
" 1861	94,443
" 1862	93,151
" 1863	100,370
" 1864	45,738

BIRMINGHAM SMALL ARMS FACTORY.

The Birmingham gun trade naturally regarded, with no little anxiety, the establishment of a Government factory on so large a scale. They, therefore, after satisfying themselves of its success, took steps to secure for this town a system which they saw would enable them to hold the position in advance of their Continental rivals they had hitherto maintained. For this purpose a Joint Stock Company was formed, and the manufactory established which is now in operation at Small Heath. In this factory the interchangeable system is carried out in its full integrity. The machinery is of the highest class, containing all the improvements which a longer experience has suggested. Every assistance has been rendered by the War Department of her Majesty's Government. Models and gauges have been obtained from Enfield, and full permission granted to inspect that establishment whenever information was required. Twenty-six acres of land have been purchased, one side bounded by the Great Western Railway, the other by the Warwick Canal. Six acres are reserved for the factory, the rest will be left for building and wharves. The factory, the main front of which is 290 feet long, forms two sides of a quadrangle, and part of a third, appended to which is a series of buildings, 320 feet long, containing the smithies, annealing room, &c., with the proof house at the extreme end. The main building is two stories high, and three stories at the angles. The rooms are all planned in squares of forty feet, the largest room being 160ft. by 40ft., the lower story is 16ft. high, the upper 17ft. 6in. The entire building is constructed with a view to the utmost possible solidity, to secure that steadiness in the working of the several machines so necessary for the attainment of the perfection of workmanship required. The planks of the lower floor are 4in. thick, those of the upper 3in., this floor is supported by trussed beams of American elm 20in. by 12in. supported by iron columns. The rooms are heated by steam conveyed through 1½in. pipes, three of which run round each room. Protection from fire is gained by two tanks placed at a height above the roof, containing together 20,000 gallons of water, they are connected with hydrants distributed at every 40 to 60ft. through the entire building. The smithy is provided with Ryder's forging machines, American drops, steam hammers, and steam drops; attached to the smithy is a room containing the furnaces for annealing and hardening, another for pickling, a third for browning the barrels, &c. Beyond the smithy is a room 80ft. by 40ft., containing lathes, &c., for the manufacture of the tools and dies required in the establishment,—the rifling room is adjoining, from which is entered the room where is conducted the milling of the barrels, locks, bands, &c. On the ground floor are also the furniture-milling room, the rough-stocking, and store rooms. On the first floor one large room contains the milling machines for some of the lighter parts of the gun, as sights, swivels, &c. On this floor also are the machines for executing the more delicate operations on the stock; one room is devoted to "making off the stocks," here is carried on the hand-filing of the locks, sights, &c., the "viewing" of the parts of the gun in all the several stages, and of the complete gun when finished. The guns are put together on this floor and packed. The machinery is driven by a pair of horizontal engines, of 30in. cylinders, and 42 inches stroke, supplied by two boilers 27ft. by 7ft. The engines are capable of working to 180 horse power. The power is communicated to the machinery by two bands, together 22 inches wide, the 18ft. fly-wheel serving as the main pulley.

The Factory has been organised by a staff of Engineers, under Mr. Corey McFarland, who for many years have had practical experience of the working of the system. A large portion of the machinery was obtained from Leeds and Manchester, and some from America. The engines and shafting are by Hick and Son, of Bolton.

At Enfield, every part of the gun, from the earliest stage, is produced in the factory. This has not been found necessary in Birmingham; advantage has been taken of having the source of supply so near at hand, to obtain certain parts in an unfinished stage from the manufacturers of the town. By this means great saving has been effected in the outlay for machinery which would otherwise have been required, without prejudice to the quality of the work, as it all passes through the finishing processes in the factory.

The factory has been planned on a scale to produce one thousand guns per week, and the works have been arranged with a view to extension at a future period, whenever it may be found necessary.

PROOF OF BARRELS.

The proving of barrels, with a view to the security of the public, is a subject which has received the careful attention of the Legislature. So far back as the year 1637, we find that a

Charter was granted by Charles the First, to the Master Warders and Society of the Mystery of Gunmaking of the City of London, with powers "for searching, viewing, and proving all manner of hand guns whatever, great and small, daggers and pistols, whether made in London or within ten miles thereof, or imported from foreign parts, or otherwise brought thither for sale." [*]

In Birmingham, the proving of barrels was left to the manufacturers themselves. Early in the present century a proof-house was erected in Weaman Street by Mr. Galton, at that time one of the most extensive manufacturers in the town. He there proved his own barrels, and those of any other gunmaker who chose to send them for that purpose. A maker, of the name of Ketland, acquired so good a reputation for the security obtained by his proof that his guns were preferred before all others, particularly in the American market. [†]

In 1813, the London gunmakers brought a bill into the House of Commons to oblige every manufacturer of fire arms to mark them with his real name and place of abode. The Birmingham gunmakers took the alarm, and opposed the bill. They represented that they made the component parts of the London guns, which differed from their own only in being put together and marked in the Metropolis. We hear no more of the bill—but we find that at this time the Birmingham gunmakers raised a fund for the erection of a public Proof-house—that they might possess the same advantage in this respect as their London competitors. They applied to Parliament, and in the year 1813, an Act was passed making compulsory the proving of all barrels either at the Proof-house of Birmingham or London. The Act applies to England only, Scotland and Ireland being specially excepted, as they are also in the subsequent Acts, including the one now in force.

The names of the fifteen gunmakers who were first called upon to fill the office of Guardians are recited; and it is worthy of note, that of the whole fifteen there is only one representative at the present day remaining in the trade.

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[*] "During the late hostilities (1802) one-half of the muskets ordered by Government were finished here, and the essential parts of the other half supplied. Our gunmakers were obliged to accompany every finished musket sent to the Office of Ordnance with the barrel and lock of another musket, in order to accommodate their brethren in London, who had interest enough to procure this regulation. For the purpose of proving these barrels a proof-house was erected by Government, at the bottom of Walmer Lane, the explosions of which were very terrific to strangers. This was under the direction of one head viewer and several subordinate ones, and was styled 'The Tower.'"—(J. Morfitt's Sketch of Birmingham.) —Editor.

[†] Morfitt also states (1802) that guns were made, "and good-looking ones too," at seven shillings and sixpence each, and proved, not by powder but by water, "which if they are capable of holding, without permitting it to ooze through their pores, they are sufficiently qualified to discharge their duty," and were sent out to Africa.—Editor.

The Act placed the management of the Birmingham Proof-house under the charge of a Proof-master, three Warders, and a body of Guardians, selected chiefly from the trade, together with certain ex-officio members. The penalty for any infringement of this Act being fixed at not more than £20 for each offence. A scale of proof, defining the weight of powder and ball to be used for each different size bore, was provided, together with a scale of prices to be charged.

In 1815, it was found necessary to enlarge the power of the Proof-house Company, and a second Act was passed for this purpose.

These regulations worked well for Birmingham; and the security which was felt in English guns materially aided in obtaining for our trade the high reputation which it enjoys. No change was made in the system pursued till 1855, when the inventions of modern times called for fresh regulations. They were embodied in an Act of Parliament passed in that year, which remains still in force. The security of the user was very greatly increased by the provisions of this Act. Under the previous one, barrels were proved only once, and that in a rather early stage of manufacture. It followed that certain descriptions of guns, as for instance—rifles when grooved, and doubled guns when jointed together—were weakened after proof, and sometimes rendered unsafe. The present Act requires that all such barrels shall be proved twice, once "provisionally," as the Act terms it, and a second time, "definitively," when the barrels are in a finished state, ready for setting up. The first proof may be regarded as for the protection of the gunmaker, to secure him from the loss that would arise from bestowing his labour on an unsound barrel; the second proof protects the user.

In order to show the degree of security afforded by the proof to which the barrels are submitted, it will be sufficient to give, as examples, the two sizes of barrels most in use for sporting and military purposes, showing the proof to which they are submitted.

	RIFLE *('577 inch, or about 25 bore).*	DOUBLE GUN *(12 bore).*
Ordinary Charge of Powder for service and sporting	68 grains	82 grains
Provisional proof charge	205 "	350 "
Definitive proof charge	137 "	219 "
Weight of bullet (conical), provisional proof	715 "	—
Weight of bullet (conical), definitive proof and service	536 "	—
Weight of bullet (spherical), provisional and definitive proof	—	535 "

Provision is made that all barrels for revolving arms shall, when proved, have the cylinders with the revolving action attached complete.

All breech-loading arms are required to be twice proved, the second time when the breech-loading action is attached and complete.

To prevent boring out, that is enlarging the bore and thus weakening the barrel after proof, the number indicating the size of the bore at the time of proof is struck on every barrel in plain figures.

THE BIRMINGHAM GUN TRADE.

Under this Act the gun trade is recognised as an associated body, to which all are entitled to belong who are master gunmakers or master gun barrel makers, carrying on business within ten miles of the Borough of Birmingham, rated to the relief of the poor at not less than fifteen pounds, and registered as by the Act provided. Every person claiming to be a member is required, on the 29th of September, to deliver in his claim with a fee of twenty-one shillings.

The trade so registered is required to meet on the 9th of March in every year, and after the election of a Chairman to proceed to fill up the places of three Guardians of the Proof-house, who retire annually but are re-eligible.

Practically, this arrangement does not work well. At the present time there are only twenty members on the Register of the Trade, although in 1857 there were 106. The guinea fee, and the other formalities attending registration, are no doubt obstacles to enrolment.

The Proof-house Company is required to balance its accounts annually, and to supply to each registered member of the trade a copy of the balance sheet, together with a tabular classified statement, showing the number of barrels sent to be proved, the number found faulty, and the character of the faults.

Power is given to the Birmingham Company to establish a rifle shooting range. Hitherto, the difficulty of finding a suitable piece of ground in the neighbourhood of the town has prevented this being carried into effect.

Certain peculiar privileges granted by the Charter of Charles the First, are reserved by this Act to the London trade, but all the regulations affecting the proof of barrels are the same for both Proof-houses; there is no longer, therefore, that distinction which was once supposed to exist between the proof of the two houses.

FOREIGN PROOF HOUSES.

In other countries the proving of barrels has received attention. In 1672, thirty-five years later than the Charter granted to the London gunmakers, the Liège gunmakers obtained an ordnance, making compulsory the proving of barrels. Several subsequent enactments were made on the subject. In one of 1819 we find the singular regulation, that all arms not marked as proved shall be seized, except those intended for the slave trade; and, as showing that the dangerous character of guns so made was fully appreciated, Clause 9 requires that under no pretence whatever shall they be put in circulation in the interior of the kingdom, but they shall be sent in packages, corded and leaded, to the border town whence they are to be exported. The regulations under which the Liège Proof-house is now conducted were framed in 1849.

In France there is a Proof-house at St. Etienne, established in the reign of Francis the First, but there is none in Paris; the makers there are left to prove their own barrels.

EMPLOYMENT OF THE TRADE.

To return to the manufacture of guns in Birmingham, it will be interesting to record the letter addresed in the reign of William the Third, by the War Department, to Sir Richard Newdigate, relating to the supply of arms which was then required. It is as follows:—

For their Ma^{ts}. Service
To S^{r}. Richard Newdigate
att Arbury
near
Warwick

These — —

S^{r}.

Pursuant to an order of this Board, Wee have directed the sending to you by the Tamworth Carryer 2 snaphance Musquetts of differing sorts for patternes desireing you will please To cause them to be shewed to ye Birmingham Workemen and upon yo^{r}. returne of their ability and readiness to undertake the making and ffixing them accordingly. Or the making Barrells or Locks only Together wth the tyme a sufficient Quantity of Barrells can be made in to answer the Trouble and charge of sending an Officer on purpose to prove the same according to the Tower proofe which is the Equall weight of powder to one of the Bullett alsoe sent you And their lowest price either for a compleat Musquett ready fixt or for a Barrell or a Lock distinct or togeather as they will undertake to make them. We shall thereupon cause further direction to be given as shall be most beneficiall for their Ma^{ts} service with a thankfull acknowledgm^{t} of y^{r} great favour and trouble afforded us herein. We are

S^{r}

Office of Ordno
10th of January,
1689.

Your most humble Serv^{s}
CH. MYDDELTON,
T. GARDINER, JOS. CHARLTON, WM. BOULTER

(Note by the late S^{r} Roger Newdegate, Bart—
" Before, all the Guns for the Army were imported from Germany.")

The term snaphance, used in this letter, is thus explained by Grose in his Treatise on Ancient Armour and Weapons. He states that it is derived from the troops who made use of it. These were a set of marauders, whom the Dutch termed "Snap-hans" or poultry stealers. The use of the match-lock exposed them, when on their marauding expeditions, to this inconvenience, that the light from the burning match pointed out their position. They were unable to provide themselves with wheel-lock guns on account of their expense. In this dilemma they formed the snaphance from a study of the wheel-lock. A flat piece of steel, furrowed in imitation of the wheel, was placed on a steel post, which was screwed beyond the pan, and made moveable. The furrowed piece being brought to stand over it, on pulling the trigger, the flint which was substituted for the pyrites in the cock, struck against it, and the spark was produced. The guns ordered from the Birmingham makers, although retaining the name, were of course an improvement on the original snaphance, and were no doubt a near approach to the flint lock of modern times.

The opportunities thus afforded in 1689 to the Birmingham men, to show their skill, produced a satisfactory result, as we find that in March, 1692, a trial order was given, followed by the further order which we here transcribe. As this order, with the letter addressed to Sir Richard Newdigate, may be regarded as the foundation of the gun trade of Birmingham, it is thought well to insert it at full length.

Contracted and agreed this fifth day of January Anno Dni 1693, and in the fifth year of the Reigne of our Soveraigne Lord and Lady King William and Queene Marye by the Grace of God of England, Scotland, France, and Ireland, Defenders of the faith &c. By virtue of an order of the Right Hon^{ble} Henry Lord Viscount Sidney Master Gen^{ll} of their Ma^{ties} Ordnance and the Board 24th Novem Last Between the Hon^{ble} the principal Officers of the same on their Ma^{ties} behalfe of the one part and William Bourne, Tho. Moore, John West, Rich^{d} Weston and Jacob Austin of Birmingham in the County of Warwick Gun Smithes of the part as folls, viz.—

Imprimis, The said William Bourne, Tho. Moore, John West, Rich^{d} Weston and Jacob Austin do Hereby severally Covenant and agree to and wth the said principall Officers of their Ma^{ties} Ordnance on their behalfe of themselves and the rest of the Gun-makers of Birmingham that they shall and will make and provide for their Ma^{ties} Service two hundred Snaphance Musquets every Month for the space of one Yeare from the Expiration of their last Contract Bearing Date the six and twentieth day of March 1692. To be three foot ten inches long, with Wallnutt-tree and Ash Stocks. And that one half of the said Musquets shall have flatt locks engraven, and the other half Round Locks and that all of them shall have brass pipes cast and brass heel plates and all the stocks varnished, and to have six Good thrids in the Breech screws, and that all the said Gun Stocks shall be made well and Substantiall and none of them Glewed.

And also that the said Musquet Barrells shall be Compleatly filed before they are proved and that they shall be proved at Birmingham according to the Tower proofe and a fitt person (who shall be impowered by this Office) shall inspect the same and marke them wth the Office Marke, and (when finished) to survey them. And that powder and bullets shall be provided and sent down at the Charge of this Office for the proofe of the said Armes.

And the said principall officers of their Ma^{ties} Ordnance (for and on the Ma^{ties} behalfe) doe agree wth the said William Bourne, Thomas Moore, John West, Rich^{d} Weston, and Jacob Austin in behalfe of themselves and the rest of the Gun Makers of Birmingham, that they shall be paid for the said Armes in manner following, viz., for every one hundred severall Armes after the Rate of seaventeene shillings per piece ready money by way of debenture wth in one week after the delivery thereof into their Ma^{ties} stores in the tower of London or Any other place within this kingdome, as the Board shall order and direct, and also that they shall be paid and allowed three shillings for the carriage of every one hundred weight from Birmingham to the tower and so proportionally to any other place And that the money shall be paid to them without any charge or trouble as they shall direct and Returne the same from time to time to Birmingham.

In Witness whereof the said parties to these prnts Interchangeably have set their hands and seals the day and year first above written

Sealed and delivered THO: LITTLETON Sigillum

in the presence of JO: CHARLTON Sigillum

WILL PHELPS WM. BOULTER Sigillum

It will be borne in mind that, shortly previous to this period, the flint musket had been first introduced, and there was doubtless a great demand for it, as it was universally adopted by all nations. Europe, at this time, was engaged in a general war; we can, therefore, readily understand how it was that

William the Third was compelled to look for a new source of supply. Doubtless, for several years after the introduction of this trade into Birmingham, the manufacturers were engaged in supplying fire-arms for the Government. After the peace of 1714, when the demand for military guns ceased, they would be in a good position to turn their attention to fowling pieces, and other guns required for the trade.

During the last century it does not appear to have been the practice of the Government to give orders for arms except when the country was engaged in war. In consequence of this our arsenals were usually nearly empty at the hour of need. As might be expected the manufacturers were not able at such times to supply the number required with sufficient promptitude. This was the case both at the commencement of the war in 1793 and again in 1803. On the first of these occasions, Colonel Miller, an artillery officer, was employed for some time in purchasing muskets for the British service in Germany.

About the year 1798, Government purchased land in Birmingham and erected the view rooms, which have since been extended into the present large establishment in Bagot Street, now under the superintendence of Captain Warlow, R.A. When in full operation, a staff of between sixty and seventy men are there engaged in viewing the arms manufactured in the town. The several parts of a gun are first examined in detail, and accurately gauged; they are then returned to the gunmaker who proceeds to set them up. At every stage of the process of setting-up, the guns are taken for examination to Bagot Street. At each view the examiner strikes his mark on the part examined, and a gun when completed bears twenty-two of such marks. Each viewer's mark has its distinctive number, so that he can be held responsible for any defect which may afterwards be discovered in the subsequent stages of manufacture, or in service.

At the breaking out of the war in 1803, Government appears to have given orders to the Birmingham manufacturers, but owing to the dispersion of their workmen in consequence of the previous want of employment, the progress at first was not great. The following table will show the number of fire-arms which were manufactured in Birmingham between 1804 and 1817:—

Arms made in Birmingham for the Board of Ordnance, from 1804 to 1815.

Years.	*Muskets.*	*Rifles.*	*Carbines.*	*Pistols.*	*Total in each year.*
From March 31 to Dec. 31 1804	36,606	85	...	...	36,691
Jan. 1 to Dec. 31, 1805	50,789	839	...	200	51,828
1806	60,756	1,597	...	1,800	62,353
1807	58,323	1,788	...	1,800	61,911
1808	87,336	3,296	...	2,759	93,391
1809	148,600	557	...	2,217	151,374
1810	182,596	1,139	...	3,060	186,795
1811	219,873	1,924	...	5,074	226,871
1812	274,026	1,525	4,123	9,067	288,741
1813	279,681	497	17,934	22,531	320,643
to July 31, 1814	168,049	721	8,595	6,784	184,149
From May to September, 1815	68,800	727	8,126	982	78,635
Total . .	1,682,610	14,695	38,778	54,474	1,743,362

And of muskets of the new model there were manufactured at Birmingham, between August, 1814, and August, 1817	84,507
Total . . .	1,827,889
During the same period (from 1803 to 1816) there were manufactured in the royal manufactory and by individuals in London	845,477
General Total . . .	2,673,366

The preceding table, showing the quantity of arms manufactured at Birmingham during the years from 1804 to 1815, by no means represents the total production. During the same period large quantities of materials—specified by the following table—were being made for the use of London manufacturers:—

Barrels for Firearms, made for the Board of Ordnance, at Birmingham, between 1805 and 1815.

Years.	*Muskets.*	*Rifles.*	*Carbines.*	*Pistols.*	*Total in each year.*
1804	80,123	62	...	...	80,185
1805	110,833	2,938	3 120	1,158	118,049
1806	112,222	15,106	4,418	2.276	134,022
1807	155,839	1,873	6,536	8,942	173,190
1808	229,355	6,334	15,245	21,402	272,336
1809	265,049	1,433	5,571	16,608	288,661
1810	299,382	133	313	6,405	306,233
1811	316,760	1,886	178	3,611	322,435
1812	409,961	2,260	7,694	16,347	436,262
1813	413,918	466	24,878	51,576	490,838
1814	282,215	91	6,566	23,313	312,185
1815	98,689	...	442	4,117	103,248
Total . .	2,774,346	32,582	74,961	155,755	3,037,644

Number of Locks made within the same period.

Years.	*Muskets.*	*Rifles.*	*Carbines.*	*Pistols.*	*Total in each year.*
1804	81,021	20	...	...	81,041
1805	91,148	4,721	4,006	...	99,875
1806	102,047	11,980	...	...	114,027
1807	119,389	8,047	1,420	6,071	134,927
1808	175,589	5,947	1,899	9,440	192,875
1809	223,345	2,412	205	8,811	234,773
1810	290,539	1,288	24	10,080	301,931
1811	333,142	2,690	179	9,643	345,654
1812	412,234	134	9,585	24,291	446,244
1813	371,694	99	23,805	62,018	457,616
1814	347,396	...	3,601	20,191	371,188
1815	98,684	...	368	...	99,052
Total . .	2,646,228	37,338	45,092	150,545	2,879,203

To this must be added the materials for nearly 1,000,000 guns, manufactured in Birmingham, and made up into finished arms by the London trade, for the East India Company; and if we add upwards of 500,000 fowling pieces, also made within the same period, the entire production of Birmingham between the years 1804, and 1815, will have reached a total of *nearly five million guns.*

It will be interesting to compare with these returns the statement of the number of arms manufactured for the French Government during the same period, when France had at its command the resources not only of the French establishments but of Belgium and Italy. The information is extracted from a work of M. C. Dupin, Field-Officer of Marine Engineers, published in 1822.

General Return of the Firearms fabricated at the Manufactories of the French Government, from the 1st September, 1802, to the 31st December 1814.

Places.	*Muskets.*	*Carbines.*	*Rifles.*	*Pistols, Pairs.*	*Total.*
Roanne . .	13,519	...	...	...	13,519
Calembourg	6,743	24	...	...	6,767
Liège . .	271,931	7,109	...	...	279,040
Versailles .	93,271	5,138	2,212	1,173½	101,794½
Turin . .	101,985	4,597	...	703	107,285
St. Etienne	631,954	41,137	...	81,536½	754,627½
Tulle . .	79,597	22,971	...	4,442	106,990
Maubeuge .	195,423	47,990	...	53,286½	296,699½
Charleville .	399,027	86,367	...	61,709	547,103
Mutzig . .	232,850	9,275	...	307	242,432
Total .	2,026,300	224,608	2,212	203,137½	2,456,257½

RECAPITULATION OF THE FABRICATION OF ARMS. (BY YEARS.)

Years.	*Muskets.*	*Carbines.*	*Rifles.*	*Pistols, Pairs.*	*Total.*
1802	89,461	13,226	...	12,005	114,692
1803	130,429	7,638	...	10,705	148,772
1804	135,496	11,134	...	14,323	161,403
1805	46,509	4,712	...	5,821	57,402
1806	147,171	13,319	631	7,459½	168,616
1807	167,287	3,804	381	21,262½	192,734½
1808	174,197	8,654	...	12,666	201,517½
1809	195,987	6,401	...	21,369	223,757
1810	230,894	8,168	...	20,732½	259,794
1811	209,462	14,533	603	19,395	243,933
1812	127,158	74,602	597	17,232	219,589
1813	209,536	47,310	...	29,038	285,884
1814	162,263	11,077	...	5,129	178,469
Total	2,026,300	224,608	2,212	203,137½	2,456,257½

A comparison of these tables, with those preceding, shows that the number of arms, manufactured for the use of our Government, exceeded by upwards of 200,000 those supplied by the manufactories of France, and if we compare the number of barrels and locks supplied from Birmingham, with the number of arms made for the French Government, it will be seen that our town produced from 500,000 to 600,000 more of those materials than the total number of arms made in the whole of the ten Government manufactories of France.

STATISTICS OF RECENT PRODUCTION.

The following tables show the total number of barrels of all kinds proved in England from the year 1855 to 1864. There are no published statistics from which the production of earlier dates can be given.

TOTAL NUMBER OF BARRELS PROVED IN ENGLAND.

1855	568,619
1856	493,657
1857	534,384
1858	444,348
1859	534,938
1860	636,947
1861	724,229
1862	996,256
1863	789,954
1864	392,973
	6,116,305
Average annual production	611,630

The numbers given in the foregoing table were proved at the following establishments. Those proved at the Government Proof-house at Birmingham show the number of military rifles manufactured by the trade for the English Government.

TABLE SHOWING THE NUMBER OF BARRELS PROVED AT THE SEVERAL ENGLISH PROOF-HOUSES.

	BIRMINGHAM.		LONDON.	ENFIELD.
Years.	*Trade Proof-house.*	*Government Proof-house.*	*Trade Proof-house.*	*Royal Factory.*
1855	264,477	131,869	172,273	
1856	275,468	119,910	98,279	
1857	302,670	136,247	95,467	
1858	198,238	127,265	92,106	26,739
1859	250,922	133,823	92,937	57,256
1860	301,021	136,298	112,228	87,405
1861	380,781	101,241	147,764	94,443
1862	622,372	45,403	235,330	93,151
1863	460,140	19,263	210,181	100,370
1864	221,726	26,930	98,579	45,738
Total . . .	3,277,815	978,249	1,355,139	505,102
Annual average	327,781	97,824	135,513	72,154

The 978,249 barrels proved at the Government Proof-house of Birmingham were "set up" into guns in London and Birmingham as follows:—

Birmingham	595,602
London	382,647

The several descriptions of barrels proved at the Birmingham Proof-house are shown in the following classified statement. It is not as perfect as could be wished, as the classification now adopted is of only recent date:—

TABLE SHOWING THE VARIOUS DESCRIPTIONS OF BARRELS PROVED AT THE TRADE PROOF-HOUSE OF BIRMINGHAM.

Years.	*Twisted.*	*Plain Iron.*	*Military Twisted.*	*Military Plain.*	*Pistols.*
1855	39,387	64,544	...	...	28,776
1856	127,774	147,694	..	...	33.252
1857	129,692	172,978	...	...	35,593
1858	56,478	141,760	...	...	36,504
1859	82,028	168,894	...	...	42,775
1860	90,676	210,345	...	...	35,098
1861	59,304	230,608	4,579	86,290	32,637
1862	35,024	200,084	187	387.077	24,288
1863	49,709	210,453	9	199,969	38,522
1864	59,981	119,508		42,242	48,181

It will be seen from the foregoing table that the use of twisted barrels for military purposes, not at any time very great, fell to an insignificant number in 1862, and ceased altogether in 1864; had the same classification been carried out prior to 1861, it would probably have been found that few, if any, twisted barrels were used for this purpose before that time. The explanation is this, that the enormous demand created by the American War for military barrels was more than the manufacturers of rolled barrels could supply; every possible means were therefore resorted to to make up the deficiency, among others, barrels were made of twisted iron, although it will be seen by reference to a subsequent table that the twisted barrels stood proof somewhat better than the plain iron ones, the proportion of failure being, twisted, 1·20 as compared with plain iron 1·35 in the hundred; yet the difficulty of obtaining them as perfectly free from flaws and specks as is required for a rifle barrel led to their rejection as soon as rolled barrels could be procured in sufficient quantities. All experience has proved that for a military rifle barrel, so long as steel is not used, there is nothing equal to the barrel produced by rolling.

As it may be interesting to show, as far as the Returns permit, the proportion of failures which occur in proof in the various descriptions of barrels, we append the following tables; it must be received, however, with the understanding that the classification is necessarily very imperfect. Barrels come within the category of twisted barrels, whether they are to be made up into single guns at 12s. to 14s. each, or into double guns of the higher class. Again, the military barrels proved at the Trade Proof-house are of various qualities. Barrels of this class are sometimes set up into common smooth-bore muskets, which are made of a low quality of iron. The barrels made for the American war were by no means of uniform quality. With these drawbacks, however, it will be seen that the breakage in this class is only 1·35 in the hundred. It has before been mentioned that the breakage in the high-quality barrels, made for the English military service, does not exceed two in a thousand.

TABLE SHOWING THE PROPORTION OF DEFECTIVE BARRELS PROVED AT THE BIRMINGHAM PROOF-HOUSE.

Twisted	5·67	per cent.
Plain iron	4·57	,,
Twisted military	1·20	,,
Plain iron	1·35	,,
Pistols	2·73	,,
Average of all descriptions	4·15	,,

The following table, showing the value of fire-arms exported is taken from the "Statistical Abstract for the United Kingdom" presented to the Houses of Parliament :—

Number and Declared Value of Fire-arms (small) Exported.

	Number.	*Value.* £.		*Number.*	*Value.* £.
1850	235,144	236,331	1858	223,718	325,543
1851	252,569	219,206	1859	171,529	168,297
1852	189,776	184,700	1860	272,948	358,847
1853	261,002	272,853	1861	315,509	515,361
1854	237,679	211,374	1862	702,254	1,573,706
1855	187,023	163,284	1863	439,122	856,009
1856	224,696	288,677	1864	260,986	344,476
1857	310,763	447,855			

This table very much understates the arms exported, except, perhaps, in the years in which the American war demand occurs. A large number of guns are sent away which are not entered at the Custom House as guns at all. This is particularly the case with the high-priced guns exported to India for sporting purposes. The value of such guns alone would in many years equal a large proportion of what is here shown as the total value of our exports.

The effect of the American war on the gun trade of Birmingham will be shown by the following monthly table, commencing with October, 1861, the earliest date at which a separate classification is given of military barrels. The attack at Charleston on Fort Sumter commenced on the 12th April, 1861, and the first orders for arms reached Birmingham on the following 9th May. We can only judge of the number made in 1861, previous to October, by the fact that the number of plain iron barrels, including all descriptions, increased from 13,445 in January to 36,275 in September, after which date the number of military barrels is separately given.

An important falling-off in the number will be observed in January, 1862. This is explained by the occurrence of the Trent affair, which led to the Order in Council, laying an embargo on the export of arms, issued on the 4th of December, 1861.

This embargo was removed early in 1862, and we therefore find the trade again actively employed throughout 1862, until in October of that year the barrels proved in Birmingham alone, in addition to a very large number supplied to the London trade, which would be proved in the London Proof-house, reached the unprecedented number of 60,345. These barrels would be made up into rifles during the following month. This number is altogether unequalled in the history of the trade. It affords strong evidence of the wonderful elasticity of the Birmingham trade, when called upon to put out its full power, a fact which shows that Government can at all times rely on the resources of the arms trade of Birmingham in any emergency that may arise. The demand for the Northern States suddenly ceased in September, 1863. Without notice the orders were withdrawn, as at that time the manufactories at Springfield and elsewhere in the United States were found sufficient to supply their wants. The smaller numbers made subsequently must have found their way to the Confederate States.

Monthly table, showing the effect of the American war on the demand for military guns.

MILITARY BARRELS PROVED AT THE BIRMINGHAM PROOF-HOUSE.

	1861.	1862.	1863.	1864.
January .		16,573	40,206	2,527
February.		23,652	38,706	2,704
March . .		17,643	11,025	3,660
April . . .		12,983	13,739	1,389
May . . .		20,189	13,419	1,893
June . . .		19,026	13,669	4,010
July . . . Estimated number of Military Barrels proved.	51,95	29,307	24,534	3,720
August . .		37,644	17,078	4,946
September		46,439	6,715	4,955
October .	32,348	60,345	5,454	4,116
November	28,693	48,758	5,307	3,937
December	29,828	54,705	10,226	4,385
	142,819	388,264	210,078	42,242

We thus find that during the four years the number of military arms made in Birmingham amounted to 783,403; of these something less than 50,000 were shipped to other countries, leaving 733,403 for America. The London trade during the same period supplied 344,802—making a total of 1,078,205.

NUMBER OF RIFLES SUPPLIED TO AMERICA DURING THE WAR OF 1861–1864.

Birmingham	733,403
London	344,802
Total	1,078,205

It will be interesting to know what the Americans have done for themselves during this period. No very authentic information can be obtained in the absence of any Official Reports, but the following information has been supplied by a gentleman in America, peculiarly well informed on all matters relating to the production of arms. He says, writing on the 21st August, 1865:--

> The Springfield (Massachusetts) Armoury during the first two years of the war produced an average of something over 500 muskets daily; and during the last two years the product was 1,000 per day. At the close of the war, the power of the private factories was equal to the same amount of production. Taken altogether, the Government and private factories were capable of producing 60,000 rifles per month.
>
> The arms now in store may be enumerated as follows:—
>
> | | |
> |---|---|
> | GUNS. | |
> | Springfield muskets | 730,000 |
> | Enfield " | 60,000 |
> | Other kinds | 212,000 |
> | Carbines: Breech-loaders | 65,000 |
> | Revolvers | 93,000 |
> | SWORDS. | |
> | Cavalry sabres | 44,000 |
> | Artillery " | 8,000 |
> | Non-commissioned Officers | 63,000 |
>
> In addition to these are the arms now in the hands of the troops, and those taken to their homes by the men mustered out of the service. The number may be put down at about equal to the number in store.

This last statement must, however, be received as a very rough estimate, in the absence of any authentic information.

PRICES.

It is difficult to give an idea of the range of prices of guns as the variety is very great. There is one gun, however, of which neither the quality nor the pattern has changed for many years past, and which will serve as a barometer for the chief branches of the trade, to indicate the variations in prices. It is the one known as the African musket. These guns are sent to the West Coast of Africa, where they are interchanged for palm oil. No ship's cargo trading with that coast is complete without a supply of them. The taste of the African is fickle in the matter of beads; a shade of colour which is in demand one season may be unsaleable the next; but it is not so with guns, wherein he rejects all improvements, and rigidly adheres to the old flint musket, with its bright barrel, which his father and his grandfather used before him. There are various patterns of these African guns, as each district has its own peculiar taste. The barrels vary considerably in length and the stocks, all of which are of beechwood, are variously stained, some black, others a brown red, and others again a bright vermillion. Probably 100,000 to 150,000 of these guns, made in Birmingham, are annually exported.

The following table shows the range of prices of the leading gun of this class:—

TABLE SHOWING THE VARIATIONS IN PRICES OF AN AFRICAN MUSKET DURING THE YEARS 1845 TO 1865.

	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1845	9/	...	9/3	...	...	...	...	...	...	...	...	9/
1846	9/	9/3	...	...	...	9/	...	...	...	...	...	9/
1847	9/	...	...	...	...	...	...	...	...	...	9/6	9/6
1848*	8/6	...	...	...	9/6	11/	11/6	12/	...	...	13/6	12/6
1849	10/6	10/6	...	...	8/6	7/6	7/	...	7/6	...	...	7/6
1850	7/6	...	...	...	...	...	...	...	...	...	...	7/
1851	7/6	...	...	...	7/	...	...	...	7/3	...	7/	7/
1852	6/9	...	...	...	...	7/	...	...	...	7/6	...	8/4
1853	8/4	...	...	...	...	...	8/	...	...	8/9	9/6	9/6
1854†	9/6	10/	...	9/6	9/3	...	9/6	...	...	10/6	...	10/6
1855	10/6	...	...	...	...	...	...	11/6	...	10/9	...	10/9
1856	10/9	...	...	...	8/6	...	...	...	...	9/9	...	9/
1857	9/	8/	...	...	7/9	...	8/9	...	...	...	...	8/9
1858	8/9	...	...	...	7/9	...	...	...	...	...	...	7/9
1859	7/9	8/	...	...	9/	...	...	8/3	...	...	...	9/
1860	9/	...	10/	...	...	...	...	...	...	...	...	10/
1861‡	10/	...	...	9/	...	...	...	...	10/	...	11/	11/
1862	11/	9/6	8/6	...	...	8/3	...	...	9/	9/6	...	9/6
1863	9/	...	8/6	8/8	...	...	8/	7/10	...	...	...	7/10
1864	7/4	...	...	...	...	7/	...	...	6/9	...	...	6/9
1865	6/9	...	6/6	...	...	...	...	...	...	...	...	...

* French Revolution. † Crimean War. ‡ American War.

The following prices of military arms supplied to the English Government are taken from a return made to the House of Commons on the 16th June, 1864, and from other sources:—

Rifled musket pattern 1853	63/8
Short rifle, sword bayonet	94/7
Cavalry carbine	63/7
Artillery carbine, sword bayonet	71/0
Oval bore Lancaster carbine, sword bayonet	88/7
Naval rifle, sword bayonet	89/7
Cavalry pistol	51/10

These prices include the cost of inspection, which is estimated at 3/7 each rifle.

The tables which follows giving descriptions of the arms used in the English service from the latter part of the last century to the present time, have been kindly supplied by Colonel Dixon, R.A., Superintendent of the Royal Small Arms Factory at Enfield. The table describing the arms now in use is most valuable, as exhibiting at one view, in minute detail, the result of the many laborious enquiries of the last fifteen years, which have been instituted by our Government, with a view of placing in the hands of our soldiers the most efficient weapons which science and skill could produce. This table may be regarded as embodying the present state of our knowedge on the subject.

ENGLISH MILITARY ARMS.

A DESCRIPTION OF THE DIFFERENT KINDS OF ENGLISH ARMS IN USE FOR LAND AND SEA SERVICE, UP TO THE YEAR 1820.

	Length of								*Weight of*						
	Barrel.		Arm, Compl.		Bayts		Arm Compl., with Bayont.		Arm Complete		Bayonet.		Arm Complete with Bayonet.		Calibre.
	ft.	in.	ft.	in.	ft.	in.	ft.	in	lb.	oz.	lb.	oz.	lb.	oz.	Inches.
MUSKETS, FLINT.															
Land, Regular, Old Pattern, A . . .	3	6	4	10	1	5	6	3	10	15	1	1	12	0	·753
India Pattern, B . .	3	3	4	7	1	5	6	0	9	11½	1	0	10	11½	„
Land, Regular, New Pattern, C . .	3	6	4	10	1	5	6	3	10	1½	0	15	11	0½	„
Light Infantry . .	3	3	4	7	1	5	6	0	10	4½	1	0¼	11	4¾	„
Pioneers' . . .	3	1	4	5	1	5	5	10	9	11½	1	0	10	11½	„
Black Sea, Long . .	3	1	4	5	1	5	5	10	9	11½	1	0	10	11½	„
Black Sea, Short .	2	2	3	6	1	5	4	11	8	7	1	0	9	7	„
RIFLES, FLINT.															
Infantry, D . . .	2	6	3	9¾	1	9½	5	7¼	9	0½	0	15½	10	0	·622
Cavalry . . .	1	8	2	11	none		2	11	6	3	none		6	3	„
CARBINES, FLINT.															
Sergeants', India Pattn.	3	1	4	4½	0	13	5	6	7	2	0	11½	7	14	·653
Sergeants', Light Infy.	2	9	4	1	1	5	5	6	7	13	1	0	8	13	·753
Cadets', Senior . .	3	0	4	3	0	9	5	0	7	10	0	7	8	1	·653
Cadets', Junior . .	2	10	4	1	0	8	4	9	6	7	0	8	6	15	„
Heavy Dragoon . .	2	2	3	5	1	3	4	8	8	1½	0	13	8	14½	·753
Elliott's . . .	2	6	3	8	0	11	4	7	7	3	0	10	7	13	·653
Short Cavalry . .	1	4	2	7	none		2	7	5	2	none		5	2	„
PISTOLS, FLINT.															
Heavy Dragoon . .	0	9	0	15	„		none		3	1	„		none		·753
Light Dragoon . .	0	9	0	15	„		„		2	10	„		„		·653
Extra Service . .	0	9	0	15	„		„		2	14	„		„		·653
Sea Service, Long . .	0	12	0	18	„		„		3	7½	„		„		·567
Sea Service, Short	0	9	0	15	„		„		3	0	„		„		·567
SPEARS.															
Sergeants' . . .	none		9	0	„		„		5	8	„		„		
PIKES.															
Land	„		8	0	„		„		5	2	„		„		
Sea	„		8	0	„		„		4	0	„		..		

	Length.		*Weight.*	
	ft.	in.	lb.	oz.
SWORDS.				
Heavy Cavalry, Straight	3	4	2	8
Light Cavalry, Scimetar	3	2	2	0
Sergeants' . . .	2	11	2	3
Drummers' . . .	2	7	1	15
Artillery . . .	2	6	2	4
Sea	2	6	2	6

A DESCRIPTION OF ARMS INTRODUCED INTO THE ENGLISH SERVICE SINCE THE YEAR 1820, UP TO NOVEMBER, 1841.

	Length of								*Weight of*						
	Barrel.		Arm Compl.		Baynts		Arm compl., with Baynt.		Arm complete.		Bayonets		Arm complete, with Bayonet.		Calibre.
	ft.	in.	ft.	in.	ft.	in.	ft.	in.	lb.	oz	lb.	oz.	lb.	oz.	Inch.
MUSKETS, PERCUSSION.															
Back-Action Lock, large or 1st Pattern . .	3	3	4	7	1	5	6	0	10	0	0	13	10	13	·753
Back-Action Lock, small or 2nd Pattern . .	3	3	4	7	1	5	6	0	9	10	0	15	10	7	,,
Altered Barrels & Locks	3	3	4	7	1	5	6	0	10	0	0	15	10	15	,,
New (Pattern 1863) .	3	3	4	7	1	5	6	0	...		...		11	2	,,
New Barrels and Locks, last Pattern . .	3	3	4	7	1	5	6	0	10	0	0	15	10	15	·753
Sea Service . . .	2	6	3	10	1	5	5	3	9	1	1	0	10	1	,,
RIFLES, PERCUSSION.															
Heavy Navy . .	2	9	4	1	none		none		11	6	none		none		·796
Infantry, (Sword Bayonet) . . .	2	6	3	10	2	2¾	5	7¾	9	6	1	15	11	5	·704
Sergeants,' (Socket Bayonet) . . .	2	9	4	1¼	1	5	5	6	9	5	0	12½	10	1½	,,
CARBINES, PERCUSSION.															
Victoria	2	2	3	6	none		none		7	13	none		none		·733
Sergeants' . . .	2	9	4	1	1	5	5	6	8	2	0	12½	8	14½	,,
Irish Police, (Elliott's)	2	2½	3	6½	0	11½	4	6	7	0	0	10	7	10	·653
PISTOL, PERCUSSION.															
Sea Service . . .	0	6	1	0	...		...		1	13	...		...		·567
SWORDS.															
Heavy Cavalry . .	...		3	6¾	...		...		2	9¼	...		...		...
Light Cavalry . . .	...		3	5½	...		...		2	5½	...		...		...
Sea Service, New Pattern . . .	...		2	5	...		...		2	12	...		...		...
LANCE	...		9	1	...		...		4	4	...		...		...

ON

MENSIO

Diameter of Bore.
Inches
·577
·577
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·577
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·451
·451
·451
·551
·539
·577
·577
·434
·358
·470
·570

of 1 in

Stocks

and the

paper

1 ozs.,

The Old Land Musket, marked A in the first preceding table, was used in the service till about 1794; none were made after that date. During the Peninsular War, the forces were generally armed with the India Pattern musket, B, and this remained more or less in the hands of the troops down to 1830. During this period a new arm, called the New Land musket, C, was gradually introduced, superseding the India Pattern. The prices paid for these three descriptions of arms were:—

Old Land Musket	£1	16	0
India Pattern, 1810	1	19	1
New Land Musket	2	13	5

The last price is an indication of the superior quality of the arm.

This old Infantry rifle, D, as carried by our troops in 1800, was used in the service down to the introduction of the Brunswick rifle, in 1840. It was generally named the "Baker" rifle. It had seven grooves, with quarter turn. It was used by the rifle regiments of the line, and by the King's German Legion. The price in 1810 was £4 8*s*. 3*d*.

WEIGHT OF DIFFERENT ARMS, WITH THEIR AMMUNITION.

	lbs.	*oz.*	*lbs.*	*oz.*
Old Land Musket, in use till 1794—				
Musket, Bayonet, and Scabbard	12	0	—	
Sixty Rounds of Ammunition	5	17	17	7
India Pattern Musket, in use till 1830—				
Musket, Bayonet, and Scabbard	10	11¼	—	
Sixty Rounds of Ammunition	5	7	16	2¼
Percussion Musket, Pattern 1842—				
Musket, Bayonet, and Scabbard	11	11	—	
Sixty Rounds of Ammunition	5	7	17	2
Brunswick Rifle—				
Rifle, Bayonet, and Scabbard	11	15	—	
Sixty Rounds of Ammunition	5	9	17	9
Minié Rifle, Pattern 1851—				
Rifle, Bayonet, and Scabbard	10	13	—	
Sixty Rounds of Ammunition	6	12	17	9
Enfield Rifle, Pattern 1853—				
Rifle, Bayonet, and Scabbard	9	12	—	
Sixty Rounds of Ammunition	5	10	15	6
Short Rifle, Pattern 1860—				
Rifle, Bayonet, and Scabbard	10	4	—	
Sixty Rounds of Ammunition	5	10	15	4

STATISTICS.

As reference has been made to the productions of Belgium and France, it will be interesting to see the extent of the trade carried on in those countries. We have the advantage of being able to refer to very much more complete statistics than are obtainable in this country. The following tables are taken from a work published by the authorities of the Liège Proof-house, and from the report of Mr. Barron, Secretary of Legation at Brussels :—

FIRE-ARMS.

GENERAL LIST OF THE FIRE-ARMS PROVED IN LIEGE DURING THE PERIOD OF 44 YEARS (FROM 1820 TO 1864).

Years.	*Single Guns.*	*Double Guns.*	*African Muskets.*	*Saddle Pistols.*	*Pocket Pistols.*	*Military Guns.*	*Total.*
1820 to 1831 (included).	423,892	98,376	153,202	190,140	327,402	394,499	1,587,511
1832	29,064	13,145	,,	18,444	80.040	189,795	330,488
1833	62,961	20,256	6,075	36,072	68,618	102,877	296,858
1834	95,167	28,104	9,320	32,332	68,132	44,455	277,510
1835	100,488	24,337	7,129	31.074	98.976	74,608	336,612
1836	152,044	24,846	8,438	44.172	140,608	71,651	441,769
1837	103,083	23,041	16,316	24,910	87.448	39.300	294,098
1838	56,753	21,226	13,906	20.708	165,274	31,542	249,409
1839	38,019	20,006	10,349	21,548	88,208	44,202	222,562
1840	49,379	23,935	9,094	23,574	88,208	18,448	212,438
1841	91,011	27,347	10,947	30,166	88,564	19,569	267,604
1842	85,561	25,511	7,092	34.416	103 726	22,744	279,050
1843	63,821	24,956	9,838	24,360	99 692	30,162	252,829
1844	79,824	27,816	14,931	50 540	117.758	31,209	321,678
1845	85,941	29,665	17,015	41,992	156,614	36,121	367,348
1846	25,037	35,188	8,754	40,004	204,144	24,525	437.652
1847	34,307	44,154	15,046	31,008	241,338	24,541	495 394
1848	71,155	37,709	16,575	21.116	258.806	115.014	520,375
1849	106,304	50,635	24,724	45,972	284.086	58,338	570,059
1850	138,546	67,537	23,116	28 796	289.374	44,063	591,432
1851	151,553	61,559	19,865	46.594	202,302	60,378	542,251
1852	159,264	57,805	17,908	39,260	172,006	58,005	503,848
1853	166,390	76,030	14,920	38,908	300,714	68,477	665,439
1854	190,586	108,796	15,727	38,066	309,094	78,720	740,989
1855	193,640	80,811	39,163	41,584	263,042	96,250	714,490
1856	211,133	103,711	40,620	41,842	257,280	82,879	737,485
1857	268,967	99,392	21,344	54,130	232,492	66,194	742,519
1858	198,211	74,723	39,114	38.502	181,660	62,563	594,773
1859	168,553	58,160	34,275	35,016	180,042	113 250	589,296
1860	139,352	80,605	52,981	30,272	189,090	179.660	671,960
1861	126,500	69,383	26,863	23,708	189,452	248,746	684,652
1862	93,475	69,925	55,642	32,232	202,310	325,689	779,273
1863	145,461	83,394	23,058	7,556	136,961	256,888	653,318
1864	202,216	96,616	13,682	11,653	172,962	177,752	674.882

STATEMENT OF THE VALUE OF FIREARMS EXPORTED FROM BELGIUM.

1850	£197,316	1858	£396,962
1851	238,430	1859	400,116
1852	218.373	1860	475,678
1853	312,810	1861	716,187
1854	382,555	1862	919,298
1855	358,758	1863	765,176
1856	408,893	1864	654,352
1857	415,537		

It is stated that the exports of recent years include large amounts of foreign arms imported into Belgium, free of duty, to be repaired or altered. The imports were, in—

1861	£76,154	1863	£41,025
1862	64,119	1864	45,414

We have seen that, during the last ten years, the total production of England was 6,116,305, but before making a comparison with the Liège trade returns, the number of arms made at the Enfield Factory must be deducted. This will bring our total to 5,611,203. The production of the Liège trade during the same ten years, according to the foregoing table, was 6,842,264, or something more than a million in excess of our make. It must be understood, however, that while the aggregate number produced in England is 17 per cent. less than that of Liège, the English arms are of greater aggregate value. The Belgians make a very large number of pocket pistols at 1*s.* 0½*d.* to 1*s.* 11*d.* each pistol. The Proof-house returns show that in the ten years the number of pocket pistols proved was 2,305,176—more than one-third of the entire make of Liège. In the English returns we have only 588,477 pistols, or little more than one-tenth, and none of these are sold at anything like the prices of the common pistols of Liège. As the demand for English work runs on superior qualities, the English makers have never attempted to make pistols of this very low class.

The superior reputation of English guns has largely given rise in Liège to the baneful practice of counterfeiting English trade marks. Every effort should be made to obtain a law to check a practice so injurious to our manufacturers and so detrimental to the public.

We are enabled to arrive at a tolerably accurate estimate of the value of the arms made by reference to the Customs Returns, which give us the number exported and their value. During the years 1865 to 1864 the number of guns exported from England was—

Number of guns	3,108,548
Declared value of ditto	£5,012,055
Value of each gun	£1 12 5

During the same years we have the Belgian value exported, but not the number of guns. We are obliged to assume that Belgium during those years exported as many of her entire make as England, although, in truth, she no doubt exported a much greater proportion, as we may be sure that the home consumption of Belgium would not be equal to that of England. The following statement will show the number of guns made and exported; the military guns made by the English makers for their Government are excluded from the calculation:—

Number of guns made in England for ordinary trade	4,632,954
Of this number England exported	3,108,548
Number of guns made in Belgium for trade	6,842,264
Number assumed to be exported by Belgium	4,590,200
Declared value of Belgian exports	£5,510,957
Value of each gun	£1 4 0

The arms manufactured by the English trade for Government may be estimated at £3 each. This is somewhat below the real value, but it will be near enough for the present purpose. These data will give the following results as the value of the production of the two trades during the ten years, 1855 to 1864 inclusive:—

ENGLAND.

4,632,954 guns at £1 12*s.* 5*d.* each	£7,509,246
978,249 Do. at £3 0*s.* 0*d.* each	£2,934,747
	£10,443,993

BELGIUM.

6,842,264 guns at £1 4s. 0d. each	£8,210,716

In this estimate credit is not given to Belgium for any arms made for their own Government by the manufacturers, as the exact number is not known. It is, however, very small, about 12,000 in the whole ten years; and, if taken into the calculation, would very little affect it. The error is very much more than compensated for, by allowing to Belgium an equal value with England for the guns retained for home trade.

We have no means of ascertaining the number of guns made in France, but the following table, showing the value exported, is taken from Mr. Barron's report:—

STATEMENT OF THE VALUE OF FIRE-ARMS EXPORTED FROM FRANCE.

1857	£123,464	1861	£760,648
1858	121,880	1862	596,796
1859	243,824	1863	522,532
1860	280,948	1864	280,024

It will be seen from this statement that France must have supplied the largest amount of arms to America in the first year of the war (1861)—on the other hand the supplies from England and Belgium did not reach their highest point till the following year. This is explained by the fact that France, on the outbreak of the war, supplied a large number of old arms which were lying in store.

The following comparative table of prices manufactured in Liège and St. Etienne, was given in evidence before the French Commissioner by a merchant engaged in the sale of Belgian and French Arms:—

COMPARATIVE PRICES OF BELGIAN AND FRENCH FIREARMS.

	Liège.			*St. Etienne.*		
	£	s.	d.	£	s.	d.
Single Guns.						
Boys' Guns, the commonest	0	4	5		...	
Ditto better	0	4	9		...	
For Men the commonest	0	5	5		...	
Ditto a little better	0	5	11	0	9	3
Ditto sham twist barrel	0	6	9	0	10	1
Ditto sham patent breech	0	8	10	0	10	11
Ditto sham Damascus	0	9	3	0	11	3
Double Guns.						
The commonest	0	11	7		...	
Common	0	14	0	0	17	8
Sham twist barrels	0	17	2	0	18	3
Ditto patent breech	1	0	2	1	1	4
Sham Damascus ditto	1	0	10	1	1	9
Iron twist barrels	1	2	4	1	8	6
Wire twist barrels	1	5	2	1	12	5
Common laminated steel barrels	1	14	0	2	1	4
Laminated steel barrels	2	4	6	2	8	1
Breech Loaders.						
Lefaucheux twist barrels	2	14	0			
Ditto Damascus	2	17	2	3	19	0
Revolving Pistols.						
Lefaucheux	1	16	10	2	6	7
Colts	1	18	2		...	
Deane and Adams	2	3	0		...	
Pocket Pistols.						
Brass, with guard, per pair	0	2	1		...	
Iron ditto ditto	0	2	7	0	3	0
Ditto secret trigger ditto	0	3	0	0	3	10
Ditto ditto screw-off barrels	0	3	10	0	6	2

SMALL ARMS TRADE ASSOCIATION.

A notice of the Birmingham Gun Trade would be incomplete without some reference to the Association which, under the title of "The Birmingham Small Arms Trade," has now for eleven years conducted a large proportion of the military work. It originally consisted of the twenty firms who, in 1854, were selected by the Government to supply the arms required on the breaking out of the Crimean war. In consequence of the sudden increase in the demand, when the orders were first given, great difficulty arose in arranging workmen's prices, and still further difficulty owing to the competition among the masters for the workmen skilled in the military branch. To remedy these evils, the Association was formed. It exists at the present time, and includes, with remarkably few exceptions, the same firms who originated it in 1854. As among its other functions, it regulates the prices to be paid to workmen, it also fixes selling prices. On this ground it has perhaps been viewed with some little jealousy by the War Department, which has, of course, been the Association's best customer. However, the fear of outside competition has always served to prevent any advantage being taken by the Association in the matter of prices. We have seen that the system is not without precedent, as the Government of William III. recognised a similar association, when it addressed the first order in a joint document to the five manufacturers then employed. Without such a system the trade could not have been carried on with the regularity necessary for the steady production of the large number of arms required from them. It has, no doubt, worked well for all concerned, for the War Department in securing steady supplies at fair prices for the masters, in guarding them from loss of profits by injurious competition, and for the workmen, in giving them regular employment at steady, remunerative wages. The Government taking this view of the question, has, from the first, recognised the Chairman as the organ of communication with the Association on all matters relating to the supplies of arms required from its members. It was through the instrumentality of this body that the Proof-house Act of 1855 received its present form, and it was they who organised the Company which has carried out the Small Arms Factory at Small Heath. They did this when convinced of the success of this system, as they saw that without such a step the military trade would be lost to Birmingham. On the one hand, they had the Enfield Factory to contend with, and on the other, the cheap hand-labour of Liège. They can now meet the requirements of the English Government, by supplying arms which will interchange with those made in their own factory, and they can offer to other Governments arms of a quality which hand-labour cannot produce.

CONCLUSION.

At the present moment (September, 1865) the gun trade of Birmingham is suffering from the reaction which always follows a period of extraordinary demand. It may be confidently expected that this state of depression will not be of long duration. The termination of the war in America will restore the demand for sporting guns for the United States market, which has always been one of the most important for our trade; but the employment which may be looked for with the greatest expectation, will arise from the demand for military arms, when a decision shall have been arrived at respecting the merits of the best breech-loader. The question will not remain long unsettled, as all the Governments of Europe are at the present time actively engaged in the enquiry. When the decision is made, a re-arming of all existing forces will become imperative, as it was when the rifle superseded the smooth-bore musket. An active demand may then confidently be expected, and Birmingham, with her present resources, will be well prepared to meet it.

THE BIRMINGHAM BUTTON TRADE.

By JOHN P. TURNER.

Before the closing years of the reign of Elizabeth, we find no trace of button making being an established trade, employing any important number of people. Buttons, in fact, are considered by Jos. Strutt, in his erudite work on the "Habits of the English," to have been used down to that time almost solely for ornament. He says:—

> "In the paintings of the 14th and succeeding centuries these ornaments frequently appear on the garments of both sexes, but in a variety of instances they are drawn without the button-holes, and placed in such situations as preclude the idea of their usefulness. Generally speaking, they were made of gold or silver, or are so depicted, with very few exceptions. There is no reason to believe that the making of buttons was considered a business until near the 17th century, when the makers of the article formed a very considerable body. Their whole trade seems to have been confined to the making of buttons worked with the needle.
>
> "In the fourth year of William and Mary, a new Act was made in favour of the button-makers, which prohibited the importation of all foreign buttons made with hair. This again was followed by another six years afterwards, imposing a penalty of 40s. for every dozen of *covered* buttons sold or set in garments, it having been represented to Parliament that many thousands of men, women, and children, within this kingdom, did depend upon the making of silk, mohair, gimp, and thread-buttons with the needle, and that great numbers of throwsters, spinners, winders, and others, were employed in preparing the material for such buttons."

Whatever may have been the results of the Acts just referred to, buttons seem to have maintained a progressive ascendancy during the reigns that followed that of William III., and became at times an extravagance, as in a comedy of the period, quoted by Fairholt, wherein an imitation of French foppery is thus satirized:—

> "Next, then, the slouching sleeve, and our large button,
> And now our coats, flank broad, like shoulder-mutton;
> Faced with fine colours—scarlet, green, and sky,
> With sleeves so large, they'll give us wings to fly.
> Next year I hope they'll cover nails and all,
> And every button like a tennis ball."

Probably, soon after the reign of George III. began, the fashion, which our forefathers can well remember, for the wearing of cloth coats, with extensive gilt buttons, commenced. In *St. James' Chronicle* of 1763 a writer, in describing the display of tradesmen aping their betters, speaks of "the myriads of gold buttons, and loops, high garteres, shoes, overgrown hats," &c., &c.; and in speaking of a certain smith, with whom he came in contact, says he had "a coat loaded with innumerable gilt buttons."

At the end of the last century the fashion for gentlemen was for "an exceedingly long tail-coat, having very large buttons; tight buckskin breeches, buttoned at the knee, and tied with bunches of ribbons;" and when gaiters were added, those were buttoned all down, and this fashion continued, with some variations, until about twenty-five years ago, and included what may be called the Augustan age of button-making in Birmingham.

In these, our grandfathers' days, the business of button-making was comparatively much more important than now, for other lines of industry have enormously increased around us, while the button trade, from various causes, can scarcely be said to maintain its ground. The fashions then in vogue—when, as already stated, gentlemen wore gilt buttons on their coats, vests, and leggings—when for ladies even, and children, metal buttons were often preferred to those from woven materials—when the varieties were fewer, and the demand more steady—when foreign competition, partly through protective duties, and partly from the lack of that development of the manufacture abroad which has since so enormously progressed—were all in favour of our "Brummagem buttons," no wonder that the trade flourished in a way it cannot be expected now to do. Times have changed. The gentleman of Victorian England wears the quietest possible buttons to his garments, and as few of them as is consistent with decency and convenience. All duties on buttons have been swept away under Sir Robert Peel. The foreigner enjoys here an open market, and, where he can make cheaper and better, has in so far depressed the home manufacture. No matter, so long as the nation benefits, and the great principles of free trade are promoted. All we hope is that other nations, in course of time, may be equally liberal and wise, and thus make the whole world a free market for all people.

At the period under review, a large shipping trade in buttons was carried on to the Continent, as well as the

United States, in addition to the very ample demands for the home trade. Easy fortunes were made, and many local families grew into affluence, some of whose descendants still maintain a respectable position among their fellow-townsmen. Both employers and artisans were well off, for while the latter was frequently enabled to earn his £2 to £4 per week, the former was often obtaining his £2,000 to £3,000 a year a sum which, though small compared with the income arising from some more important manufactures, was a large amount to be derived from such an article as buttons, unless in very exceptional cases.

Among the houses that took an important position in the trade at that time, Messrs. Hammond, Turner, and Sons, Mr. Edward Armfield, Messrs. Bullivant, Messrs. Sanders and Perkins, and Mr. J. Aston, are still represented, and can date back their origin to something more or less than a century ago. All their early prosperity was owing to the metal button trade, as was the case with several other good houses that have no longer a name or successor to keep them in mind. It is not often that a manufacturing business, in an article so subject to the changes of fashion, continues to exist in vigour and influence through a succession of generations, and the writer of this may therefore be forgiven the boast, that his house stands alone in having through four generations maintained a leading ascendancy in the trade.*

It may be interesting to trace the gradual digression from the "long-tail blue," or snuff-brown coat with gilt buttons; and breeches be-buttoned at the pockets and the knees, with leggings buttoned all down to the ancle, to the present almost buttonless style of garments. The first serious innovation

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*Among those to whom the Birmingham button manufacture was particularly indebted in the last century may be mentioned :—

Mr. Baddeley, the earliest manufacturer of whom anything is known. He was the inventor of the oval chuck, and several other appliances which greatly assisted in the improvement of the manufacture. He lived in the Square, and retired from business about 1739.

John Taylor, originally a cabinet-maker, but who held the office of High Sheriff of Warwickshire in 1756. An account of his manufactory is to be found in "Hutton's History of Birmingham." He introduced a number of improvements in gilt, plated, and lacquered buttons; the value of the weekly produce of buttons alone at his works being at one time estimated at not less than £800 a week.

Matthew Boulton, who as early as 1745 had introduced great improvements in the manufacture of certain classes of buttons, particularly inlaid and steel. After the establishment of the Soho Works, the steel buttons cut with facets employed one of the many departments of his manufactory, and were sold at 140 guineas the gross.

Mr. Clay, the inventor of papier maché, who in 1778 took out a patent for manufacturing buttons in this material. This patent was afterwards extended, on the ground of his having invented a new method of securing the shanks. He also manufactured buttons of slate on a large scale.

Ralph Heaton, who established works for manufacturing button shanks on an improved principle. in Slaney Street, shortly before the commencement of the present century.—EDITOR seems to have been made by the covered buttons introduced by Mr. B. Sanders, who, after losing an easy fortune in Denmark, in the bombardment of Copenhagen by Lord Nelson, came to this country hoping to obtain at least a competence by commencing business (at first in a very small way) in this town, little dreaming that he was destined to make so rapid a fortune. He introduced first a covered button made of cloth or lasting, and with an iron shank. The genius of his eldest son, Mr. B. Sanders, jun., improved this into what is called the flexible shank button, that is, with a tuft of canvass protruding through the back instead of a shank, through which the needle could pass in any direction. This button presents, moreover, a soft surface to the garment, and was for both reasons a decided improvement. It was patented in 1825, and being a beautifully made button, suited to a growing taste in the direction of simplicity and plainness, had an enormous sale. By this and a subsequent patent for a similar button covered with silk on the back, the Messrs. Sanders, now of Bromsgrove, made their name and money; while those who had been reaping pleasant harvests from the gilt and metal buttons hitherto in vogue, gradually ceded ground to the producers of the covered and flexible buttons in their various styles. Among the most notable of these was the fancy silk button, with a centred pattern, which was patented by Mr. William Elliott, in 1837. This also had a great run for a few years, and redeemed the trade for a while from a commoner class of button before in use. The patent, however, was hotly disputed, and many imitations divided the profits derivable from it. Nevertheless, so great was the sale, that as many as sixty looms were at one time employed in London in making the special material required; and Elliott was still successful in securing a good fortune from its sale. This button led to many others of a cognate character in silk twist, velvet, &c., &c., and the liability of such to wear out on the edge in buttoning suggested some mode of protection to that part that should not interfere with the general symmetry of the button. A very neat and ingenious mode of meeting this difficulty was invented and patented shortly after by Mr. John Chatwin, appropriately called the "corded edge button."

All these fashions have passed away in this country, but abroad, in France and Germany, a variety of styles of fancy silk buttons have continued to be made and sold up to the present day.

About 1841, another important novelty in the trade was first brought out by Mr. John Aston, who patented an invention of that versatile and erratic genius, at that period well known in Birmingham, Mr. Humphrey Jeffries, for the "three-fold linen button;" that is a button formed of a linen covering and ring of metal so put together that both sides and centre are completely covered with separate pieces of linen, and thus produced quite flat. This being an excessively neat and convenient button was, and is, largely patronised by housewives for all underclothing, having superseded the old thread button of Dorsetshire, formed of a ring of wire with threads drawn over and over it, and gathered in the centre, which our grandmothers will remember to have been their only resource for such purposes, and not a bad one either.

The linen button patented by Mr. John Aston was improved upon by Mr. Wm. Elliott, and the two working in concert made a very successful business of it until their mutual patents expired. The original article and various deviations from it are now made by a number of houses, and some idea of the importance of the manufacture may be formed from the fact that Messrs. Dain, Watts, and Manton (Mr. Elliott's successors), consumed, last year, 1864, for this small article alone, 63,000 yards of cloth, and 34 tons of metal, for which nearly 250 hands were employed, an amount that would seem incredible on less trustworthy authority than that of the firm themselves.

The mention of covered buttons naturally led to some notice of the linen button, otherwise it would be more proper in point of time to refer to another very important revolution in the trade produced by what is called the "*horn button,*" but which should be more correctly termed the "*hoof button;*" this pretty, but excessively cheap article, so largely used in children's and ladies' dresses, being made from the hoof of cattle, cut into form, dyed, and pressed into beautiful designs. No doubt, some clumsy descriptions of this button were made from this material beyond the date of existing memories;* but their great improvement and development was first effected from twenty-five to thirty years ago, by Monsieur Emile Bassot, of Paris, a gentleman to whom the button trade, in France especially, owes many important changes and material progress. My own long intimacy with the gentleman, and a previous close connection and esteem on the part of my predecessors, particularly the late Mr. William Turner, enables me to bear confident testimony to his peculiar and special genius, and I feel most pleased to have this opportunity of paying a friendly tribute to his devoted intelligence in promoting "la boutonnerie." He was elected a juror in the great Exhibitions of 1851 and 1855, and was regarded up to the time of his death, last year, as the first authority in button-making in Paris. This invention, originated by M. Bassot, was taken up with great spirit in our own town and neighbourhood. Mr. T. W. Ingram, and Mr. Thomas Cox, of Birmingham, and Mr. Thomas Harris, of Halesowen, may be specially named as having each and all borne a well-merited palm for the excellence, beauty, and variety of their productions in this material. For a good many years they enjoyed an unflagging and well-deserved support, and sent their productions to all parts of the world; but times have again changed—the demand for such buttons has either fallen off altogether or verged into varieties in which the French makers have exercised a successful competition, and they have secured by far the greater portion of what remains of the trade. Hoof button-making still lingers at Halesowen and Birmingham, but it serves only to remind us of "the days that are no more."

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* "Horn" buttons, as early as 1801, at least, were largely manufactured in Birmingham, the commonest qualities being sold at 5½*d.* per gross. Hutton speaks of "the cloaks of our grandmothers, ornamented with a horn button nearly the size of a crown-piece, a watch, or a John-apple, curiously wrought, as having passed through the Birmingham press."

A glance into any book on costume will often serve to raise a smile at the queer figures our ancestors made of themselves, and no doubt our own descendants will be equally amused at the chimney pots of our gentlemen, and the repulsive crinoline of our ladies. But be that as it may, these various changes involve new styles of buttons and buttoning, and when they are, as by chance sometimes happens, for the better, let us be thankful.

The introduction of jackets, in a variety of colours and materials, for men's wear, in place of the old dress coat, or stiff surtout, has opened an opportunity for the adoption of a button suitable to them; something that could be made in various shades, and not of the same material as the coat itself. Thus arose a demand for the "Vegetable Ivory," or "Corozo Nut" button, which are the most recent introduction the trade has seen. About ten years ago they were only known as a very occasional article, though the same material has long been to some extent in use for beads and ornaments of various kinds. Since that time they have become universally used, and are largely manufactured in Birmingham.

The nuts from which these buttons are made are imported from the countries of Central and the northern ports of South America, such as Carthagena and neighbouring ports. They grow in clusters on trees bearing something the character of the palm, but probably never so lofty or so large. Each cluster is enclosed in an outer case, as with chestnuts, and the whole bunch, thus enclosed, is about as large as the two clenched fists; but as much of this is shell, and a further portion core, there is but a lesser half of actual material good for use. This, in a good nut, is of a beautiful milky white, something softer to the touch, and lighter in weight than ivory; it is readily turned in the lathe, and can be dyed in a variety of shades, as brown, drab, slate, grey, &c., &c., to suit the endless varieties of material that are used in the garments of to-day. In these articles too Birmingham maintains a pre-eminence, for though they are made both in France and Germany, their competition does not surpass us in neutral markets, and we are even sellers of them to some extent in theirs. There are probably now, at busy moments, some fifteen or sixteen tons per week of these nuts, worth to the consumer from £25 to £30 per ton, cut up into buttons in Birmingham, and some 700 hands employed in their manufacture. The use of them has suggested the introduction of various composite materials by way of imitations, but only one is worthy of notice, that of Mr. J. S. Manton, who patented in 1850 a material made from mineral earth, which is very effective for some styles of buttons and jewellery, and for which the demand is rapidly increasing. The real vegetable ivory button, however, will always maintain its ground so long as fashion requires a button of that species.

Hitherto I have noticed only those various branches of the button trade which have been connected with special phases of its history during the last forty years, and which are themselves interesting and important, necessarily omitting such minor matters of a similar character as have been only partial or very transitory; but there remain still to be considered those staple branches of the trade, which through all changes have continued to be of major importance. These may be mainly classed under two heads, metal buttons and pearl buttons. Metal—for all uniform buttons, whether military, naval, or livery; for fancy buttons, gilt, plated, chased, enamelled, stamped, or pierced, &c.; for composite buttons, where they are partly made of other materials, as pearl, glass, wood, &c.; for parts or foundations of covered buttons, as flexible shank and linen buttons; for trouser buttons; for various kinds of cheap buttons, or japanned iron or tin, zincs, for slopsellers, military work, or export—must be an invariable "*matière première*" in the manufacture of buttons. It is never used *pure* for the better class of work, but is always a compound of copper with brass or spelter in various proportions as may be required for different kinds and qualities of work; thus we have the term "gilding metal," that is, metal so compounded as to be suitable for gilding. The gilt buttons of our grandfathers' days were of course gilt by the old process with quicksilver, which, for plain and solid articles of that character, was much more durable and satisfactory than the modern electro-gilding process, which, however excellent it is for many articles, has been considered by the trade to have materially aided in driving out the old gilt button. The button that went out gilded by the new process soon turned coppery or tarnished. Public confidence was shaken, and the inferiority of the goods probably exercised a not unimportant influence in bringing on that depression in the old trade, which dates from about 1840. Some years later the employers and artisans interested appointed a deputation to wait on Prince Albert, in order to induce him to promote the restoration of a dying fashion by himself wearing fancy gilt buttons. The rivalry of different firms for the fortunate honour of being the producers of such sets of buttons as should be selected by the Prince from the large assortment offered to his taste on that occasion, the urbanity of the Prince's reception of them, and so forth, were intoxicating topics of gossip and speculation among the trade in my boyhood. But hope deferred maketh the heart sick. These sanguine gentlemen all had gradually to learn that a Prince, however gracious, does not carry the fiats of the fickle goddess in his button-hole, and that the revolutions of fashion are to be met by measures more in accordance with sound judgment, good taste, and manly industry.

There are still many houses doing a fair amount of business in metal buttons. Hammond, Turner and Sons for best fancy and uniform buttons, and Smith and Wright for large quantities of military and other contract orders have the pre-eminence; but there are ten or twelve others here and in London who hold a respectable place in similar lines, besides a crowd of smaller manufacturers who provide the commoner goods, for the most part bought up by establishments such as the above.

The consumption of metals for buttons is not at all comparable with what it must have been twenty-five years ago.

Still it is not inconsiderable; and though I have not been able to obtain approximate statistics on this point, I should think, however, that six or eight tons are used per week of metal, properly so called, that is the cruder article before referred to, whether for gilding or for commoner purposes, and as much more of iron and tin. My friend, Mr. J. S. Wright, who is perhaps better able to judge of this particular matter than myself, puts the amount down at half as much again, but neither of us have any means of judging very nearly.

Pearl buttons have always been an important branch of the trade, and, considering the delicacy and beauty of the material, a very interesting one. No elaborate machinery is employed in the production of these buttons, and perhaps never can be made profitably available for them. At any rate hitherto skilled hand labour, assisted by nothing but the foot-lathe, is alone employed, and therein this branch is distinguished from all others where steam power and machinery, more or less complicated, is generally used, but not so universally as in many other articles. The mother-of-pearl which is cut into buttons is of various kinds, and some of great value.

The white-edged Macassar shells are fished almost entirely from the seas round Macassar, in the East Indies. These shells, the "mothers" of the orient pearls so coveted by beauty, are the finest in size and the purest in grain of any in the world. Their value in this town varies from £140 to £160 per ton.

The yellow-edged Manilla shells are similar in size and character, but have a yellow tinge on their border, which diminishes their value, and, moreover, they are more brittle in turning. They are used chiefly in the Sheffield trade for knife handles; their value is from £100 to £120 per ton.

The Bombay and Alexandria shells, smaller in size and less delicate in tint and clearness, are found in the Persian Gulf and the Red Sea, very various in quality and usefulness, sometimes worth £70 to £80 per ton, at others not worth £30. Good and even indifferent shells of this class have latterly been scarce, inducing a suspicion that the fisheries are becoming exhausted.

Another very beautiful shell is brought from the Archipelago of the Pacific Ocean, and is called the black shell, because when polished it throws out a very dark shade, full, however, of beautiful rainbow tints, exquisitely blended. Portions of the shells, when properly turned, produce also white buttons, nearly as clear and good as those from the best Macassar shells. These buttons are not now much in demand, so that the shell does not bear its just value, which would otherwise rank next to the Manilla shells.

The last and poorest species of shell is also found in the Pacific, and chiefly in the neighbourhood of the pearl islands in the bay of Panama. These "Panama shells" are often not much larger than oyster shells, though then, of course, they bear but small value. When of fair size, they average from £20 to £30 per ton, and are used naturally for the poorer kinds of buttons.

It is said that 5*s.* is capital enough to begin making pearl buttons. This, however, is not quite true; but no doubt a few pounds will enable a respectable workman to commence on his own account, if so disposed. Hence there are a multitude of small makers in this trade, and very few establishments pretending to employ anything like fifty pairs of hands. As a rule, a few larger houses supply the material to these smaller masters, of whom there are above a hundred in the town, and take all they produce, thus practically becoming the real employers.

There are still probably about 2,000 pairs of hands engaged in pearl button making in Birmingham, and about two tons or more of the best shells, and probably some twenty tons more of the commoner kinds, are cut up weekly by them. Some five years ago, just previous to the American war, this industry was much more important than at present, probably employing half as many more individuals again, as now; but from the cessation of almost all export for the States in the intervening period, it has been very depressed, and is but beginning to revive with the renewal of the American demand. In the particular styles in which the Birmingham makers excel, they continue to engross what trade is going, but for a variety of fancy sorts in vest and dress buttons, the French workers have long maintained a pre-eminence; and for cheapness and quantity in particular kinds, the Vienna manufacturers defy our competition, and export very largely to neutral markets.

The following analysis of the importation of the various kinds of shell for five years since 1859, is kindly furnished us by Mr. J. S. Wright, and may prove interesting:—

In 1859	there were	1,800	tons,	of the total value of	£66,000
,, 1860	,,	1,200	,,	,,	47.000
,, 1861	,,	650	,,	,,	31,000
,, 1862	,,	1,100	,,	,,	31,000
,, 1863	,,	800	,,	,,	25,000

About one-quarter of this would probably be re-exported to the Continent or consumed in Sheffield, so that about three-quarters of the whole may be reckoned as consumed in Birmingham for buttons.

There are still other branches of the button trade worthy of notice, but to treat of all would be an endless and futile task. It were easy to write a long list of materials from which buttons have been made, but very difficult to name one from which they have NOT been made. Every possible kind of metal, from iron to gold, whether pure or mixed—every conceivable woven fabric, from canvas up to the finest satin and velvet—every natural production, capable of being turned, cut, or pressed, as wood, horn, hoof, pearl, bone, ivory, jet, ivory nuts, &c.—every manufactured material, of which the same may be said, as caoutchouc, leather, papier maché, glass, porcelain, &c.—have entered more or less into the manufacture of buttons, and some of them constantly.

Bone buttons have, from time immemorial, been manufactured for common purposes, and form almost the only branch in the trade in this country *not* peculiar to Birmingham, inasmuch as they are produced in many places, as well as here, where bone is plentiful and cheap, or where the manufacturer can procure it, as waste, from the making of larger rticles.

Wood buttons, for great coats, jackets, &c., are also constantly in use, and are made usually from box wood, dyed black, or, for extra qualities, from the best hard woods, as ebony, cocoa, &c.

Glass buttons form a very interesting branch of the trade, whether in combination with metal or otherwise, as for best fancy styles, or whether plain or cut in various patterns, as imitations of jet. Though these buttons are many of them sold very cheaply, as low in fact as two-pence a gross, in plain small ball shapes, for children's shoes, yet the processes they require are tedious, and in many of the best cut ones very few gross can be produced weekly by one pair of hands, so that larger numbers are employed compared with the quantities produced than in other branches. Probably over 300 people are engaged in this branch alone; yet this is very much less than the numbers employed in Paris, and very far short of those engaged in a similar way in Bohemia, that great seat of glass manufacture generally, and whence are exported to all parts of the world innumerable thousands of grosses of cheap fancy glass buttons.

Porcelain buttons are not made in England at all, but were first invented by a Birmingham man, Mr. R. Prosser,* who patented the idea some twenty to twenty-five years since, and in connection with the celebrated North Staffordshire house of Minton and Co. made and sold them. The French, however, took up the trade at an early period, and soon compelled Minton and Co. to abandon a hopeless competition, and, with the exception of some that are less well made in Aix-la-Chapelle, have continued to command all markets for them, and sell immense quantities. They have adapted and perfected so unequalled a method of making these buttons, that it may be safely said no article was ever made so well, so perfectly, and so cheaply. A great gross, that is 12 gross, each of 12 dozen, is sold for 11*d.*, every button beautifully made, regularly carded on good paper, and admirably turned out in every respect. The very paper they are on would be thought worth the money.

Having now reviewed, in a general way, the various branches of the trade worthy of any special notice, I must add a few words about the artisans employed in them, and of these the numbers are considerable, though, naturally, very varying according to circumstances.

From as careful an analysis as I have been enabled to make, I should put down their numbers thus :—

Employed in metal button making of all kinds, about	1,200
In covered buttons, including linen, about	1,500
In pearl buttons, about	2,000
In vegetable ivory buttons, about	700
In other kinds, as glass, horn, bone, wood, &c., about	600
Total	6,000

The greatest number employed in any one manufactory is in that of Mr. Wm. Aston, Princip Street, where there are from 700 to 800; then follow, Dain, Watts, and Manton; Hammond, Turner, and Sons; and Smith and Wright; but as these employ many outworkers, the numbers actually engaged on their premises would not give a just comparative estimate. Then, again, there are certain houses having no manufactory at all, who keep on a number of small makers, a practice especially common in the pearl button trade.

As to the people themselves, out of the 6,000 at which I estimated their numbers, full two-thirds, if not more, are women and children, whose condition may be best understood by referring to the Government Commissioners' report lately published. I fear there are among them as many instances of a low state of education and morals as can be found in any other trade where many women and children are engaged. The mere fact that they are employed must always be an index of a lower criterion of character than obtains in trades where skilled men are mostly required, who can thus afford to keep their wives at home and send their young children to school. On the other hand, the button trade can boast as many of the more respectable and intelligent artisans as any other, and perhaps more than most. The nature of the work involves, in many cases, considerable artistic skill, or educated art, as in closing, tool making, burnishing, and in the turning of pearl and other buttons, and where so high a degree of workmanship is not necessary, there is still a certain variety of labour and careful attention to be given to it that involve some exercise of the mind as well as of the mere *physique;* as in stamping, pressing, polishing, cutting out, &c., &c., so that a certain kind of sharpening of the wits goes on, more than exists in many other kinds of labour.

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* I find it stated in a well-known French periodical, *Les Grand Usines*, in an article on the manufactory of these very buttons, at Briare, that the invention is really very ancient, and that before 1706 the master button makers in porcelain formed a community; be this as it may have been, in France, the present mode of making them is certainly new.

Some of the men still earn good wages, in occasional instances from £2 to £4 per week, though the average, of course, would run much lower, say about 25*s.* in ordinary times, when trade is neither very bad, or remarkably good. There are instances of women's earnings reaching as high as 16*s.* to 20*s.* per week, but that is only with individuals very skilful in their particular work, or with heads of shops. The average of adult women's wages is not more than 7*s.* to 9*s.*, which, for girls and young children, runs down to 1*s.* 6*d.* or 1*s.*

Many of these last come to work as young as six years old, and numbers are employed between that age and twelve as attendants on older hands, or doing such work as is merely mechanical. For this reason the button trade became an important one for enquiry as to the operation of a proposed Factory Act to be applied to Birmingham, the particulars of which may be found in detail in Mr. J. E. White's Report in the Blue Book of 1864, from which it will be seen that all employers felt the evil attendant upon the employment of very young children as at present carried on, and the majority of them believed that some sort of legislation on the subject might be beneficially introduced. There is, however, to my mind, a greater evil than this, which public opinion cannot too loudly condemn, and which, though perhaps too difficult to legislate for, unless very partially, should yet be prominently noticed in any Government enquiry. I ventured, therefore to draw Mr. White's particular attention to the very frequent practice of *married women*, whether *with* or without families, working in shops—a very common thing in the button trade. A young girl enters a manufactory, and acquires a certain skill in her work, worth perhaps eight shillings to ten shillings a week, which becomes an useful addition to the family income while she lives at home, and no doubt the habit of industry thus acquired is also good; but shortly she marries, and very frequently instead of turning to useful housewifely duties, and seeing that her home is orderly, neat, and clean for her husband's reception and comfort, and so making her true value lie there; she, or may be he also, is dazzled with the direct prospect of the certain addition she is capable of making to their income by going to work. Thus home is neglected, domestic habits on the part of both are impaired, and the social beauty of the domestic hearth, and the true wealth that the well-keeping of it must bring, lost in the attraction of present gain. Then, when a baby comes, the necessity of increased means is more pressingly felt; and though then, if ever, is the time when every wife has enough to do to fulfil her duty at home, they often choose to pay some shillings per week to a neighbour to look after the child, in order to jingle in their pockets the miserable balance of their earnings at the week's end. Can anyone wonder that, in many of these cases, the husband prefers the public house, where, at any rate, he can enjoy a quiet pipe in a well-sanded apartment and a pleasant chat with shopmates, to a home which *cannot* be kept clean, children dirty and restless from want of due attention and food improperly cooked, and often wasted? No doubt the training girls receive by going into manufactories is not one suited to make good wives of them; nevertheless, they may always learn enough to do first duties tolerably, and their woman's nature and instincts will soon adapt themselves to those pursuits and occupations for which they are specially fitted, so that this drawback is not of weight sufficient to discourage the employment of girls in this way, which offer so many other advantages.

It is remarkable too, that, after all, the money women can so earn is very small, lower, I believe, than most other places where women are largely employed, as in Yorkshire and Lancashire. It may be put down, as an average, at not more than one-third the wages of men, a remuneration that leaves the motive for the labour of married women really so weak when reasonably viewed, that one feels amazed to find so many yielding to it. No doubt when a husband is thrown out of work, or is ill, the ability of the wife to stem the inroads of absolute poverty may be well employed; but these are exceptions, not the rule, and I am convinced that many husbands are encouraged in idleness from this very circumstance.

The condition of the workers is naturally the worst in the shops of very small employers, with whom competition is too close to enable them to spend money in improving the comforts of those about them, and who employ as a rule the least skilled hands, and for that reason the worst paid and least materially elevated in every respect. There are, however, special classes in the larger manufactories quite on a par with the lowest in these respects, the "nut crackers," for instance, little lads who are engaged in breaking the outer shells off the vegetable ivory nuts ready for the workman who saws them up. Every little rascal who is too wild for steady work can be set to do this, and consequently they are the veriest little Arabs to be found in any branch of industry, their destructive propensities being however happily utilised in the manner described.

No notice of button making would be complete without some comparative reference to the position of the trade abroad. Certain classes of buttons are made in every country on a limited scale, since where official uniforms are required the small quantities of buttons needed to furnish them cannot be always conveniently imported, and the metropolis of every country contains therefore some manufacture of buttons. The great seats of this industry, however, are confined to a few localities. In France, where the development of the trade has been something magnificent within the last quarter of a century, it is followed mainly in Paris, and some few places within a circuit of sixty miles from it, which I shall notice presently; also at Lyons.

In Germany there are a multitude of houses producing all the cheaper kinds of fancy buttons in the Rhenish Provinces of Prussia, chiefly about Elberfeld and Barwed; and in Bohemia, as before stated; vast quantities of cheap fancy glass buttons are produced at Prague and adjacent towns; at Vienna also the pearl button-making rivals Birmingham, and has extinguished its competition in certain descriptions.

There is no extensive industry in button making in other countries of Europe, unless I include the existence of one very considerable manufactory at Milan; but in the United States there are again large quantities of all kinds produced. In proof of the resources of the makers there, it may be mentioned that on the breaking out of the civil war the Northern States found no need to come to Europe for the sudden and enormous demand there must have been for army and navy buttons, but were supplied throughout by their own manufacturers; the Southern States naturally imported all they could by the blockade runners from Europe.

One peculiarity of the United States' productions has been the making of considerable quantities of vulcanized rubber buttons, a description which has not been patronised in Europe, partly, perhaps, from their peculiar smell. As, however, the United States are large importers of buttons from Europe, and not at all exporters hither, we English manufacturers do not hear much about our brethren of the guild on the other side the ocean.

Of the position of the trade in France, I give the following account as received from a Parisian friend, who, from his intimate acquaintance with all its branches, and with most of the manufacturers there, has good opportunities for forming a correct opinion. There is, however, the same difficulty there in arriving at precise statistics as here, in consequence of the number of small makers, which number from 80 to 100 for various kinds of metal buttons alone, from 70 to 80 for covered buttons, and from 70 to 80 for other kinds.

There are employed in Paris *alone*:—

A.—In metal buttons of all kinds, and including buttons mounted or set with metal	about	2,800
B.—In covered buttons	„	1,800
C.—In other kinds of buttons—as horn, pearl, bone, &c.	„	2,000
Total—say		6,600

As for bone, pearl, vegetable ivory, wood, &c., buttons, they are made chiefly at Meru and its neighbouring towns, as Chaumont, Valdampierre, Bearnais, from 40 to 60 miles from Paris, on the northern side, where, probably, fully 2,000 people are employed in these branches; perhaps another 1,000 or so being employed in the making of sewn-silk, &c., buttons, about Apremont, near Chantilly.

The porcelain buttons are made at Briare and Montereau, each some sixty miles from Paris. At the former is the celebrated establishment of Mons. Bapterosse, employing about 1,000 people, besides another 4,000 or more of outworkers in a circuit of twenty miles, who however are all women and children, to whom the buttons are given out at their homes to be carded or sewn on, or to have the shanks fixed in, which has to be done by hand. At the latter place there are also between 200 to 300 hands employed for the same buttons, with a corresponding number of outworkers.

There are also about 2,000 persons employed in some kinds of button making in the prisons in France, where the Government seems to have succeeded better than our own in utilising the labour of criminals.

At Lyons, where various kinds of very cheap buttons are made, there are another 2,000 or so employed in their production, so that altogether this industry may engage in the whole of France about 20,000 persons, a tangible proof that its development must exceed considerably that of the trade here, though when comparing France with England we must add about 1,000 more to the numbers given as employed in Birmingham, to allow for those who are engaged in London and other parts of the country in button making. Some twenty to thirty years ago there were more buttons exported hence to France than there were from France hither. Now, however, this state of matters is quite reversed; and though some few Birmingham buttons, more especially linen ones, for shirts, are sold in France in no inconsiderable quantities; and though some of us keep up a spirited competition, even in those fancy goods in which the French particularly excel, they must be admitted on the whole to be masters of the course in our own markets in all except the ordinary styles of plain goods. Various causes have conspired to produce this result:—

Firstly—The unmistakable fact that in all fancy articles the ingenuity, taste, and artistic skill which are the peculiar gifts of the French are more important elements than accidental advantages, such as the possession of a lower rate of labour, or of cheaper raw material.

Secondly—The French have a wider and easier market. Great Britain, by the abolition of all duties on imported buttons, is entirely open to foreign manufacturers, while to buyers from other ports of Europe, Paris is a more central mart, and being the acknowledged leader of fashion, is for every reason universally visited, and multitudes throng there to select their stocks for millinery or tailors' purposes, who would never dream of coming to Birmingham. True it is that for many distant places, such as our own colonies, the East and West Indies, &c., &c., London and Manchester, where

Birmingham goods are well represented, are very generally visited; but even this does not apply with much force to buyers for such articles as suit milliners and tailors, who, if they do come here from those localities always go to Paris as well.

Thirdly—within the period referred to "La Boutonnerie" has been energetically promoted in Paris by a series of business-like and clever men, who have made it their special work. Every trade has its seasons of vigour and decay, due in some measure to the activity or inertness of its professors, irrespective of fortuitous circumstances. When a period of such activity occurs, in combination with favourable commercial conditions, trade advances with rapid strides, and this I consider to have been the case of the button trade in Paris during the past and present generation.

In the cost of all metals, copper, steel, iron, and in such raw materials as pearl shells, corozo nuts, and perhaps hoofs—in the materials for covered buttons (silk excepted)—and in the cost of labour, Birmingham enjoys certain advantages, as compared with Paris, which have enabled her to maintain her position in the trade. In Paris, the makers have to import most of their materials from England, and as to wages, those of women, who are the most numerous, average 10 to 20 per cent. higher than in England, while there are many cases, in warehouses and responsible positions, where they get clerks' salaries, a thing unheard of here. Some kinds of work, moreover, which are done here by skilled women, are done there by men, and consequently cost more, although, perhaps, such men do not get large wages for men. In other respects men's wages are probably much about the same as here, certainly not less.

These remarks, however, do not refer to the country towns in France where buttons are made, where wages no doubt range at lower rates.

With regard to the button trade in Germany, unfortunately it has not been in my power to obtain particulars of an equally trustworthy character with those respecting the trade in France, but its importance cannot well be overrated. If we except the porcelain buttons, the quantity exported from Germany to other countries must far exceed that from both England and France together, although in value the comparison might perhaps be the other way, as the Germans vied in cheapness, especially in the production of fancy goods, where some taste is required in the imitation of more expensive articles. Besides almost exclusively supplying their own regions of the Zollverein, they are by far the largest producers for the middle and lower classes in such countries as Russia, Italy, Spain, and others, which buy almost all the buttons they consume. In England and France they divide with the native manufacturers the local requirements, and export enormously to the United States and other distant regions. When goods, however, are produced at almost unreasonably low prices, capital is not so quickly accumulated or fortunes made, and we do not hear of more than moderate wealth among the button makers of Germany even in the most favourable cases. Their manufactories are seldom on a large scale or their machinery very perfect, but they have a number of makeshift ways of producing sufficiently good results without involving much outlay.

The number of persons employed in the Elberfeld district must be greater than in Birmingham, but probably not so great as in France, and their earnings would no doubt be smaller than those obtained in either, probably about on a par with those in the country districts of France. In Bohemia, where all the glass buttons are made, they must be much lower still; yet it is not simply in the price of labour that the Germans have an advantage over manufacturers elsewhere. They may fairly claim the merit of exercising that kind of ingenuity in the highest degree whose aim is to produce the cheapest possible article with the best possible appearance, and in outstripping all rivals in this particular way they have also exhibited as much taste as circumstances would permit. This, however, applies almost exclusively to light fancy goods; in most plain and heavier articles, such as brace buttons, ivory buttons, and others again, where perfection of tools and workmanship is of first importance, as in bone buttons, the better kinds of uniform buttons, &c., they do not succeed so well. On the whole, we find them formidable rivals, and have as much to learn from them in one way as they from us in another.

My aim has been throughout this essay to give a popular and readable account of the button trade, without introducing technicalities, or even attempting any description of processes, and which would moreover involve details quite incomprehensible to general readers and which, however interesting to *see*, cannot be made so in description, those who wish to know more on such points may pay a visit to some of our workshops, and if they take a genuine interest in such matters, will readily find opportunities for gratifying their curiosity.

[Horn or Hoof buttons were made in Birmingham more than eighty years ago, and are referred to in a curious description of the Birmingham Manufactures in 1780 (which is prefixed to the "Birmingham Directory" of that date), and is valuable as a contemporary account:—"It would be no easy task to enumerate the infinite diversity of Buttons manufactured here: it may be sufficient to observe that those made of gold, silver, steel, pearl, paper, &c., are universally allowed to excel the produce of any other place in this kingdom; and are it must be admitted finished with all the richness and splendour of which they are capable. . . . . There is one sort of button which on account of its having been produced by an artist of eminence in this town deserves particular attention. It is that which is inlaid with divers other metals: was first attempted about 20 years ago: and then, though in no respect so complete as at present met with great and merited encouragement. Button making like many other arts was originally a very tedious and expensive process. The Button consisted of one solid piece of metal: and the ornaments upon the face of it were the work of an engraver. To give despatch to the execution of this manufacture and to render it more advantageous to the manufacturer, various instruments were invented, some of which were either solely produced or greatly improved by Birmingham artists. Among others the Press, and Stamp, and the Engine for turning the mould, deservedly ought to be mentioned. The first gives the form to the Button, and the second the objects represented thereupon: but the Engine, which was the invention of a man of great mechanical knowledge, was perhaps not the least acquisition of the three. An inconceivable despatch was introduced: and the formation of the mould was now effected with surprising ease and expedition: but what most enhanced the importance of the discovery was, that the bones and hoofs of beasts, which till this period had been thought articles of little or no value, became articles of great consequence in the manufacture of Buttons, and were imported into this kingdom in large quantities from Ireland and other places."]—EDITOR.

THE JEWELLERY AND GILT TOY TRADES.

By J. S. WRIGHT.*

We have no record nor date upon which to form a correct idea as to the period when the manufacture of jewellery became one of the trades of Birmingham.† At the commencement of the present century, it is probable that some four hundred artisans were employed in ten or twelve manufactories: those working in gold made principally seals, keys, and watch chains, whilst the silver workers produced shoe, knee, and other buckles, as well as considerable quantities of comb ornaments set with conspicuous paste or imitation stones. The trade continued to prosper in spite of buckles going out, and other freaks of fashion, until 1825, when the great catastrophe which fell upon commerce generally almost annihilated the jewellery trade; nor did it revive to any considerable extent for ten years, during which time the artisans suffered the greatest privations.

The chief seat of trade formerly was Derby, where large quantities of common and medium jewellery were produced, Edinburgh and London manufacturing the finest goods. The trade has almost disappeared from the former places, and London now depends mainly upon Birmingham for the supply of articles suitable for the middle classes. Since 1836 the trade may be said to have been in a flourishing condition, but during the last twenty years its progress has been almost marvellous. The discovery of gold in Australia and California, the vastly increased wealth of England and her Colonies, together with the desire for personal adornment, have united to give an unparalleled prosperity to this branch of industry, which now directly and indirectly affords employment to a larger number of persons than any other trade in Birmingham, whilst its increasing demand for novelties undoubtedly tends to develop in a larger degree the inventive and artistic faculties of a considerable portion of the inhabitants. With the exception of a few machinists (and in very busy seasons the workmen in the gun trade), the jewellers are the best paid of the Birmingham artisans. The rate of course varies considerably, but he is a poor workman who can only earn 25*s.* weekly; 30*s.* to 50*s.* may be considered the average of wages. Some obtain much more. Enamellers frequently gain as much as from £3 to £5 weekly. Boys are usually apprenticed at fourteen, when they earn 4*s.* per week, which is increased annually until they are twenty-one, when they generally receive 10*s.* or 11*s.*, working as a rule from eight to seven, with intervals of an hour and a quarter for dinner, and half an hour for tea. Youths sometimes make a considerable sum by working overtime.

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* In justice to Mr. Wright, it should be stated that he is unconnected with the trades described, and undertook the task of reporting on the history and condition of a most important branch of Birmingham manufactures only when it was found that no other arrangement could be made.—Editor.

† In the Birmingham Directory of 1780 the names and addresses of twenty-six "Jewellers" are given, implying that the trade was even then carried on to some considerable extent. Since, however, few of the names are to be found afterwards, and one or two are evidently "Platers, &c.," and especially as the classification of "Jewellers" is not given in the Directory of 1803, we may fairly infer that the first classification was irregular, or that the trade had rapidly declined.—Editor.

It is somewhat singular, and contrary to what might have been expected, that only comparatively few females are employed in this trade; its cleanliness, and the delicate manipulation required, would appear to adapt it especially for women. Two branches only give them employment—one is the "guard-chain," and the other is the ordinary press work, when they cut out or form the "roughs;" but a considerable number indirectly obtain their living in connection with the trade by making paper and leather boxes, which are largely used, not only to protect, but also to set-off the finished article.

In several trades it frequently happens that the best paid workmen do not take the highest social position. The ease with which high wages are earned in busy seasons tempts many men to waste their time and health in vicious indulgencies. As a rule, the working jewellers occupy a higher social position than other artisans. They reside in comfortable dwellings; their clothes are generally good, and do not betray the "working man." This may be attributed to the cleanly nature of their work. They are not given so much to dissipation as some classes. Quiet and continued application, rather than muscular strength, is necessary (a steady hand being indispensable), and all tend to the formation of more orderly habits.

The jewellery trade furnishes a most interesting and important illustration of a peculiarity which places Birmingham in favourable contrast with every other large town and centre of industry in the kingdom — namely, the great number of small but independent manufacturers it supports. There are comparatively few large manufactories, most of the articles for which it is noted being produced in shops where five to fifty hands are employed. Probably nine out of every ten of the master jewellers, who are now carrying on business on their own account, were originally workmen. In one instance, at least, not less than twelve independent concerns are now in active operation, each employing a number of hands; the principals of these twelve concerns having all been employed as apprentices or workmen in a manufactory which itself has been established within twenty-five years.

All that is needed for a workman to start as a master is a peculiarly-shaped bench and a leather apron, one or two pounds worth of tools (including a blow-pipe), and for material, a few sovereigns, and some ounces of copper and zinc. His shop may be the top-room of his house, or a small building over the wash-house, at a rent of *2s.* or *2s. 6d.* per week, and the indispensable gas-jet, which the Gas Company will supply on credit. With these appliances, and a skilful hand, he may produce scarf-pins, studs, links, rings, lockets, &c., &c., for all of which he will find a ready market on the Saturday among the numerous "factors,"* whose special business it is to supply the shopkeepers throughout the country.

The causes thus indicated which have so largely contributed to the establishment and prosperity of the jewellery trade in Birmingham would, however, be insufficient of themselves to give it a permanent character. No doubt success for a time largely contributes to the permanence of a trade; dealers in the various tools, stones, and materials required are drawn together, and this affords great facility to manufacturers, especially to those of small capital. Then the demand for novelty stimulates the ingenuity of the producer, and, by ensuring a continued supply of new styles, develops trade. There is no doubt it is the superiority of the workmanship that has continued the trade in its prosperous condition; and it is upon this superiority that reliance may be placed for its further development and permanent establishment in this locality.

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* The word "Factor" is always used in Birmingham to denote the dealer or home-merchant who collects goods from the manufacturers, and through his travellers and other connections distributes products to ironmongers, jewellers, and shopkeepers generally throughout the country. The use of the word doubtless came from the "Factories" in the East Indies.—EDITOR.

There is scarcely any branch of the trade in which a most marked improvement has not taken place during the last quarter of a century, and a class of best work is now produced that is unsurpassed either in delicacy of finish or artistic effect.

Style is becoming a study amongst managers and working men; one firm requires all apprentices to undertake to attend some School of Art during the whole term of their apprenticeship, so as to fit them to become art workmen when of age. Combinations of colours in jewellery are now better understood by buyers, and the public now no longer, as in the time of our parents, wears one brooch winter and summer, and on any colour of dress.

No doubt Birmingham has profitted by the free intercourse between this and foreign countries. Many ideas may have been gathered from France and Italy, yet it will be found that the manufacturers of jewellery are not copyists, and though they may study the character and style of ancient and modern workers, yet they design and invent in the main for themselves, and their productions have acquired a reputation that rivals that possessed by Paris or Rome.

It is well known that the agents of the German manufacturers continually transmit to their principals the newest patterns which Birmingham produces. These are copied to a considerable extent at Frankfort, Hanau, and other towns, and afterwards enter into competition with the original articles in foreign, colonial, and sometimes in the home markets too.

There was not a large display of jewellery in the Exhibitions of either 1851 or 1862. The manufacturing jewellers, supplying the shopkeepers in London, could not have exhibited their productions without diverting trade from their customers, and thus eventually injuring themselves; but it is only necessary to walk from the Bank to Hyde Park to enable any person to form an idea of the ingenuity, skill, and taste of the Birmingham artisans. The shopkeeper will not voluntarily admit that his articles are Birmingham manufacture, yet we believe we speak within bounds if we say at least one-half of all the gold and silver work seen in the shops of the London jewellers is the production of this town. It would not be right to pass without mentioning that the School of Art has largely contributed to the development of the artistic faculty in our jewellers. Many hundreds of our workmen have been trained there. Its influence is growing, and there is no doubt that it will be still more useful in the future to this and similar trades. Still it is a matter of regret that only a very small number of employers appreciate its importance or render it pecuniary support.

The reasons assigned in the introduction to this paper for the prosperity of the jewellery trade in general might have existed, and yet only a small proportion of the trade have been carried on in Birmingham; but there is no doubt that it has been attracted to this locality partly in consequence of the skill which our artisans had acquired as workers in metal. During a large part of last century, metal buckles and buttons were largely manufactured here,* and persons employed in various branches of these trades—as solderers, lapidaries, engravers, &c., would be readily transformed into workers in jewellery.

The application of dies and machinery, in the production of these articles, has contributed to the extraordinary extension of the trade. Formerly, the whole article was produced by one man, and was, consequently, very expensive; but, owing to the sub-division of labour, and the use of machinery, articles formerly made in units are now produced in hundreds.

Let us take a common ear-ring, or locket, for example. Under the old system the gold would have been beaten out by hand to the thickness required, and then forced into the proper shape by repeated hammering; the edges of the back and front, filed that they might join correctly, after which it would be soldered and finished—all this being the work of one person.

Now, a die is cut or engraved, the gold rolled at the steam mill to the requisite gauge, then blanks or discs are cut out by a screw-press, stamped and cut to the exact shape desired (also by the press), all this being done so rapidly, that twenty are produced in the same time as one was formerly made.

It is curious to note how this trade has located itself in one part of the town—the St. Paul's district—which has, in fact, become the "jewellers' quarter," the boundaries being almost as clearly defined as the Ghetto (or Jews quarter) in Rome and many continental cities. There is scarcely a workshop to be found in any other locality—and yet, twenty-five years since, this site was almost entirely occupied by small gardens. In most instances the residence of the master joins the shopping or factory in which the workmen are employed. The following selection from the sign-boards in one of the streets of this quarter will illustrate this. Nearly all the occupations, it will be observed, are connected with, or dependent on, the jewellery trade—out of fifty-four whose names and businesses are exhibited :—

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* Sir Edward Thomason in his curious Memoirs says:—"I have heard my father [who was, in 1780, a 'buckle maker, at 21, Colmore Row,'] say, that his manufactory completed one thousand pairs of buckles per diem, or six thousand pairs per week, when in full work. In those days buckles were worn by both sexes, and also by children, and were principally made of white metal which looked like silver: some few were plated with silver. I heard my father say, that he invented one pattern which he called the 'Silver Penny,' by which pattern he cleared above £1,000 sterling."—EDITOR.

15 are Jewellers.
2 — Stone dealers.
4 — Stampers and die sinkers.
3 — Lapidaries.
2 — Silversmiths.
1 — Glass cutter.
1 — Medallist and die engraver.
4 — Chain makers.
4 — Chasers and engravers.
2 — Electro-gilders and platers.
2 — Black ornament makers
1 — Jewellers' case maker.

Only an approximate estimate of the numbers of the persons employed in this trade can be given, but the best estimate we can form of the total numbers is as follows :—

Masters		500 to 600
Jewellers proper	3,000	
Silversmiths	1,000	
Gold and Silver Chain makers	1,500	
Gilt Toy makers	1,000	
Box makers, Die sinkers, and subsidiary trades	1,000	
	7,500	

Allowing the moderate number of 3 to each gives upwards of 20,000 persons supported by this trade alone.

The term "Gold," as understood in the Jewellery trade, must not be taken to mean pure gold, which is never used. The standard gold, as used in the coin of the realm, has 22 parts pure in 24; watch cases have 18 parts in 24 pure; and the usual quality of "gold" work made and sold here, and elsewhere, is alloyed with 9 parts of inferior metal in 24; and, as might be expected, considerable quantities are produced with a larger amount of alloy.

Articles sold in France as gold must be officially stamped, and must contain 75 per cent. of pure gold. Previous to the late revival of the trade in Birmingham, the greater part of the gold was alloyed with copper only, which accounts for the red colour of most of the productions of half a century since. In Holland this colour is highly approved at the present day.

The use of zinc, alone and in combination with silver, as alloys, have enabled the manufacturers to produce the rich variations of yellow and coloured gold now so much in demand. The gold is melted and alloyed by the manufacturers themselves. It is furnished to them in grains or bars by the refiners, whose business it is to separate the gold from the dross and inferior metals with which it is usually combined.

A large quantity of obsolete or old-fashioned ornaments, old Foreign and English coin, is melted and re-used. The Bank of England supplies old coin to manufacturers at £3 17*s.* 10½*d.* per ounce. This, as well as old Foreign coin, is in demand, as containing exactly ascertained amounts of alloy; and for the same, if not for other reasons, it is probable that large quantities of new sovereigns find their way to the crucible.

The total value of gold used in the trade has been estimated at £600,000 to £700,000 yearly, and the silver at £100,000 to £150,000. Altogether, the value of the gold and silver consumed in Birmingham, in the jewellery and kindred trades, may be estimated at about one million pounds; the precious stones and their imitations at a quarter of a million pounds more.

PRECIOUS STONES.

In the extensive manufacture of jewellery, precious stones take a most important place, and in many articles constitute, as all are aware, the chief value—the gold and the workmanship bearing a similar proportion as the frame does to the painting it encloses.

The stones used embrace every known sort, and of course are importations. The dealers supply them ready for use—the best setters are employed almost exclusively in that one branch of the trade, and by long practice, frequently become very skilful, and earn high wages.

But although the stone may be intrinsically the most valuable part of the jewel, yet its effect is greatly enhanced by the manner of its setting and the character of the ornament in which it is placed. Even the diamond is improved in brilliancy by the skill of the setter, and the effect of emeralds, amethysts, carbuncles, and other coloured stones is enhanced by means of pieces of silvered or coloured foil. Pearls are used largely, generally the smaller sorts. These are obtained in the Straits, between the mainland and Ceylon, the Red Sea, Persian Gulf, Eastern Archipelago, and the western coast of Central America. In the button and other trades the shell (or mother-o'-pearl) is used, whilst the jewellers work up the true pearl. This offspring is found sometimes in the fleshy part of the oyster, and sometimes in its nacreous covering, a handful of pearls being frequently of more value than a shipload of mother-o'-pearl shells, yet each is useful in its way. For whilst the button made from the shell is most necessary, and adds (when properly sewn on) so much to the comfort of the husband, the little granular substance, which probably was a source of trouble to the parent oyster, forms part of a graceful ornament for the wife, and both afford employment and provide food, clothing, and comforts alike for the artisan in Birmingham, and the uncivilised natives of New Guinea.

Although, like precious stones, pearls are imported, yet sometimes the workers in the mother-o'-pearl shells find embedded therein real pearls, which always have a ready sale, at prices varying from 1*s.* to several pounds each. A few years since, a small lot of shells was brought to Birmingham which, either from ignorance or mistake, had not been cleared of the pearls at the fishery. A considerable number was found and sold, and one, especially, was sold by the man who had bought the shell for working into buttons, for £40; the purchaser, we believe, re-sold the same for a profit of £160; and we have heard it was afterwards held in Paris for sale at £800!

A large portion of the pearls are drilled and strung before they arrive in England, and these are usually set in hemispheres, each pearl being sewn through—this is a delicate operation requiring, as may be supposed, a steady hand and a fine instrument to bisect a tiny globe of less size than a pin's head.

Formerly Mosaics produced in Rome were largely used, but are now out of fashion. Shell cameos, however, are still in regular but not large demand. A better class of stone cameos is used in considerable quantities, these being fifteen to twenty times the value of shell cameos.

As to the total value of precious stones and pearls dealers are naturally disinclined to state the extent of their trade, so it is with some hesitation we venture to give the above-named estimate; but forty years since there was only one stone-dealer in Birmingham, and now there are thirteen. Doubtless the most valuable diamonds are set in London, but the greatest number are used in Birmingham. An ordinary manufacturer will produce ear-rings containing upwards of a hundred diamonds, besides a quantity of brilliants; and it is no uncommon thing for rings to be set in Birmingham with diamonds of the value of £100 and upwards. Several manufacturers will keep a stock of diamonds, the value varying from 5*s.* to £50 each, and worth £1,000 to £2,000 in the aggregate.

A very great rise has taken place in the value of diamonds during the last twenty years; and within the last four or five years emeralds and other precious stones of fine quality have more than doubled in value. Sorts selling formerly at £3 to £4 per carat now fetch £10 to £12; amethysts that were worth 50*s.* an ounce are now worth £8 and upwards; and it is estimated that the consumption of diamonds has increased tenfold within fifteen years in Birmingham alone.

GOLD AND SILVER CHAINS.

Guard-chains, now an important branch of the trade, were at the end of the last century made by one or two manufacturers in a single pattern, out of brass-wire, which was either left its natural colour, or was finished by being silvered or gilt. Silver guard-chains were made first in Birmingham, about the year 1806. Gold chains, for a similar purpose, have not been made to any extent for a longer period than thirty-five years, but are now produced in Birmingham to the value of, at least, two hundred and fifty thousand pounds annually. There are forty-seven master manufacturers, some employing 200 to 300 hands, but the greater part not more than ten to twenty. Altogether 1,500 or 1,600 persons are engaged in chain-making, about 500 being young women, who earn good wages, and maintain a most respectable appearance. In this branch of the jewellery trade, steam-power and elaborate machinery are employed to a small extent in producing the links of the chains, which are made from strips of wire, and afterwards soldered together, cut, engraved, and polished as may be necessary.

Some ingenious machines have lately been patented, which produce very neat patterns of chains, completely finished, from thin strips of metal. Such chains will, no doubt, be largely used, not only as guard-chains, but for pendants to other ornaments.

GILT TOY TRADE.

Gilt Toys is a technical term embracing personal ornaments of all descriptions in which metals, gilt, or simply coloured, are used, either alone or in combination with imitation or real stones, cameos, Mosaics, ivory, bone, jet, and other materials. The trade is largely carried on in Birmingham, and has displayed, to a considerable extent, articles of a similar kind which were imported from France and Germany. The beauty of many of these articles, both as regards form and finish, is surprising. The process of electro-gilding, to which the development of the trade is principally owing, enables the manufacturer to produce a surface that is frequently undistinguishable from the finest gold work. It need not be said, however, that it is not so durable—the slight film of gold soon oxidizes and wears away.

The aim of the manufacturer is to produce, by ready and cheap methods, imitations of the more elaborate and delicately finished jewellery, and he does this by means of tools, such as the press and the stamp. The fine Etruscan style, which is now so current in gold work, is imitated in a die, and stamped up to bear a close resemblance. The beautiful hinges and snaps, made by the goldsmith with the most delicate tools, are effectually imitated by bending, or making an indentation, by a screw press, in a simple piece of metal.

The low price at which these beautiful ornaments are produced is astonishing. For instance a locket, which in gold might be worth from 15*s*. to 30*s*., is produced in metal gilt for a penny; in fact one article which lately had a considerable "run" was made with hinges and clasp, in the form of a volume, and with good likenesses of the Prince and Princess of Wales, and was sold wholesale for about one halfpenny each!

It will be admitted that "the force of cheapness cannot much further go!" There is no valid reason why the factory girl should not display her gilt buckle and brooch of the same design as the golden one worn by the lady of the villa. Art may thus serve the community by cheapening the cost of the beautiful, and affording gratification to the humblest members of society, by superior designs reproduced in the cheapest possible form, and attainable by all.

Between gilt toys and ornaments made of gold there is an intermediate description, designated plated jewellery. The articles are for the same use, are of equally varied character, and are made by the processes common to "Gold Jewellery" and "Gilt Toys." The peculiarity consists in the application, by fusion, of thin plates of gold or silver to the thicker plates of common metal, which form the basis and give solidity to the article. These articles are much more durable than those slightly coated with gold or silver by the electro process, and if the "gold plate" is also gilt the appearance is equal to gold itself, and the durability sufficient for all common purposes.

The trade in jewellery is principally Home and Colonial. No doubt with a moderate tariff the United States would take a very large quantity of jewellery from this town, but the duty having to be paid on the material (which commands the same price there as here) so enhances the cost that, except in rare instances, Birmingham goods are practically excluded. To make this clear, a brooch of the value of £9 may contain gold of the value of £5. A duty of 30 per cent., and cost of transmission, enhances the price 40 per cent., and gives a protection to the native artisan equivalent to 90 per cent.

As might have been expected, except Great Britain, Australia is the best customer, and her demand is mainly for best goods. The following figures have been extracted from Government returns:—

Jewellery Imports.		Jewellery Exports.	
1861	£65,932	1861	£199,783
1862	73,586	1862	231.526
1863	71,184	1863	186,475

THE BIRMINGHAM SADDLERY TRADE.

By THOMAS MIDDLEMORE.

Of the great antiquity of the saddlery trade, and of its intimate connection with the early history of the manufactures of Birmingham, there can be no doubt. Tegg, informs us in his "Chronologist's Companion," that saddles were first used in England in the year 1340; and he also assigns the year 1380 as the date of the introduction of the side or ladies' saddle.

The Saddlers' Company, which forms one of the ancient Trade Guilds of London, and has its Hall situated in Cheapside, is of great antiquity. Its Charter was granted by Edward the First, and the privileges of the Craft were confirmed and extended by several of the succeeding kings.

As early as the year 1538, Leland, who then visited this town, refers to the "Lorimers that make bittes," together with other ironworkers, as maintaining the people of the district. Again, in a work published in 1691, entitled "The New State of England," the writer tells us that "Bromicham drives a good trade in iron and steel wares, *saddles and bridles*, which find good vent at London, Ireland, and other parts."

It seems pretty clear that Birmingham, besides being noted as an ancient manufacturing centre of saddlers' ironmongery, possessed also a hide and leather market, of great antiquity and importance. The following extract from "Hutton's History of the Town" throws much light on this point:—

> There is no appearance of that necessary article (leather) among us; yet Birmingham was once a famous market for leather. Digbeth not only abounded with tanners, but large numbers of hides arrived weekly for sale, and here the whole country found a supply. When the weather would allow, they were ranged in columns in the High-street, and at other times deposited in the Leather Hall, at the east end of New-street, appropriated for their reception. This market was of great antiquity, perhaps not less than 700 years, and con-

tinued to the beginning of the 18th century. We have two officers, annually chosen, who are named leather sealers, from a power given them by ancient charter to mark the vendible hides, but now the leather sealers have no duty but that of taking an elegant dinner. Shops are erected on tan vats, the Leather Hall is gone to destruction, and in 1781 we were reduced to one solitary tanner.

There are ancient maps in the town, showing the extensive range of the tan pits, and the position of the Leather Hall. Many old documents, also bearing on the duties of the "leather sealers," and the customs of the "Leather Hall," help fully to confirm the general truth of Hutton's statements. Hence we are justified in assuming that an important leather market, and several tanneries, of much repute, flourished in the town from a very early date—that they were deemed of sufficient extent to be regulated by special laws, and protected by charter; but that, for reasons which do not appear clear, these leading trades of the town had sunk before Hutton's time (the latter part of the last century) into a state of comparative insignificance.

Whilst many of the variety of saddles now in use are of recent introduction, having been designed to meet the very varied wants of the present time, but few articles in use in past years are now obsolete, since the same wants that existed formerly exist still, and we have to trace the invention of modern varieties rather to wants superadded to old ones, than to wants taking the place of old ones. To this, however, we must make several exceptions. Some twenty years ago, two kinds of harness, known severally as the curricle and tandem harness, were much in vogue. The curricle was merely a bar, generally of plated metal that was added to the ordinary pair-horse carriage harness; it was connected with the pads, and ran from the back of one horse to that of the other. As the curricle bar was commonly handsomely ornamented in silver plate, it formed a very striking and showy feature of the harness. The tandem harness is so well understood, that no explanation is necessary. Both of these kinds of harness may now be looked upon as obsolete with respect to our own country; they are, nevertheless, very often made for foreign markets.

A notable example of an article that is now obsolete is found in the pillion—a sort of chair-saddle designed for women. The seat was in the form of a closed back chair, from which a stuffed footboard was suspended for the support of the rider's feet. The lower part of the pillion was padded like an ordinary saddle. The pillion was only used with the man's saddle, behind which it was fastened by means of straps.

Before the reign of Elizabeth, when carriages were not known in England, the pillion was in general use amongst people of the higher ranks of society. In the carriage, however, the pillion found a formidable rival that drove it rapidly from one social stratum to another, until it found a last stronghold with the farmer and small tradesman, to whose business a horse was a necessary adjunct, and who would naturally wish to turn his horse to account for family purposes. In this connection the pillion is remembered by many of the elderly of the present day. One cannot help envying one's forefathers the agreeable *tête-a-tête* which the pillion doubtless afforded.

In giving an account of the varieties that late years have seen introduced into the saddlery trade, we are attempting a most difficult task. On account of the vast number of these varieties, and of their technical nature, our description will be a very general one; and with a view of giving our readers a clear conception of this part of our subject, we shall class the varieties we have to refer to under the several objects that they were designed to fulfil.

We will take first those inventions that have been introduced with a view to give ease to the rider. The "Somerset" saddle is a conspicuous example in this class. This saddle differs from the ordinary one in having a roll or bolster added, extending along the *cantle* or back of the saddle, and down each side of the flaps. These rolls furnish an agreeable support for the back and legs. The "Somerset" saddle is but little used in England, but in many foreign countries, and especially in hilly districts, it is found of much service, and extensively employed. In certain markets, indeed, the "Somerset" has almost an exclusive sale.

It has been a great aim with the saddler to give softness and elasticity to the seat of the saddle, without availing himself of padding, or of any other appliance which will alter the form of the saddle and thereby destroy that clearness and compactness of outline on which its chief elegance depends. It is obvious that if the jolting caused by the movements of the horse can be diminished, horse exercise would be rendered much less fatiguing than it now is, and the danger of rupture being caused by heavy jumping in hunting, would be considerably lessened. With a view, therefore, of getting this elasticity of seat, many inventions more or less successful have been introduced. None of these inventions are of universal use, though many of them are efficient and turned to account when the proposed advantages are required by the purchaser.

We will notice, lastly, as one of the inventions intended to give ease to the rider, the "Leaping Head," or "Third Crutch," for the ladies' saddle. This invention is merely an additional crutch, placed on the near side of the saddle, a few inches below the ordinary one. The "leaping head" gives the rider a greater purchase on her saddle, and therefore a securer seat. It is of special service to the rider when she is going "cross country."

The next class of inventions requiring a few words, is one in which the aim is to give the rider a more perfect control over his horse. And here we may mention the multitude of bridles adapted to suit the varying conditions of the horse's mouth. We have thus the "Snaffle" bridle, for the light-mouthed animal; the "Pelham," where a stronger strain has to be applied; the "Weymouth," or "Curb-bit," for harder mouths still; and so on, until we come to the "Chifney," "Gag," "Secundum," and "Hanoverian," that are suited only to the pulling horse, or runaway. By these means, therefore, almost every possible variety of temperament and character of mouth is suitably provided for.

Many inventions might also be mentioned, which are designed to check and cure the bad habits of a horse. The "Martingal," by keeping the head of the horse down, often cures a rearing horse, and generally prevents the attempt. The "kicking straps," when attached to a set of harness, will likewise prevent any mischance resulting from the efforts of the kicker.

Our third and last division comprises those inventions by means of which injury is saved to the horse, or rider, in case accident should occur. We direct attention, in the first place, to that most excellent stirrup known as the "Spring Stirrup," which is made so as to open if a pressure is applied to the side from *within*. It is not unfrequently the case, when the rider has fallen, that his foot becomes entangled in the stirrup, and he is thus dragged along the ground by the horse, at the risk of serious injury. This danger is completely removed by the spring stirrup. In districts such as Buenos Ayres, where the country abounds in holes which cause the horses to fall, this invention is in great request, and is found to be of essential service. Many hunting men in our own country are also users of the spring stirrup.

Many plans have been brought forward for releasing the horse from his harness, when he has fallen down. These are nearly all modifications of the arrangements of the "Tugs," and are too technical to be understood by the ordinary reader.

With respect to the increase of the Saddlery trade since the year 1849, we shall avail ourselves of the statistics furnished by the Government Trade and Navigation Accounts; and by noting the increase that has taken place for the United Kingdom, from 1849 to 1865, we shall be sufficiently accurate in assigning the same rates of increase for the Birmingham trade. In the year 1849 the declared value of the exports of saddlery and harness for the United Kingdom was £102,724. In the year 1864 we find that this amount was increased to £345,419. In other words the trade has, from the year 1849, considerably more than trebled in amount. The exports for the first four months of the present year were £130,662, or at the rate of nearly £400,000 per year. The great extension of this branch of trade is mainly attributable to the growth of our colonies in the Cape and Australia.

In reference to the supply of raw material, it will be necessary to glance for a moment at the different countries of the world from which the leather trade gets the supply of its raw material, and the several purposes for which each kind is used.

The kind that merits our chief notice is that known by the name of *hides;* by which we mean the hides from neats' cattle generally. Hides are imported to this country in two states, the "*dry*" and the "*salted*," or "*wet*" one, and it is necessary that they should be prepared in either the dry or salted condition, in order to protect them from putrefaction, to which the gelatine and other animal matter that the raw hide contains renders it liable. When the hide reaches the tanner it is converted into leather by being treated with some solution having *tannin* as its essential basis. From these foreign hides are obtained the greater part of the soles of our boots and shoes. When these hides are treated with oil they are made into *buff leather,* from which the accoutrements and belts of our soldiers are chiefly manufactured. For this purpose foreign hides are found more suitable than those taken from our home cattle; these latter are much flawed by marks, caused by a grub known by the name of the weevil; from these marks the foreign hides are more or less free. Vast quantities of these hides are annually sent to this country from the Brazils, La Plata, and the west coast of South America. Our own Colonies also, in the West Indies, the Cape, and Australia, furnish us with fair supplies. Some few are also shipped from Mauritius and the Continent of Europe. A good idea may be formed of the extent of this particular branch of the leather trade, when we call to mind that the quantity of hides (dry and salted) imported in the year 1864 was 954,760cwt., to which, if we add the hides imported in the *tanned* and *dressed* states, we shall find that our imports were equivalent to nearly 3,000,000 hides.

Kips (*i.e.*, skins from beasts between a calf and a cow) are manufactured largely for the upper leathers of boots and shoes. They are sent to us chiefly from India. The calf skins that we import are supplied principally by the Continent. They serve the same purposes as *kips*, but are used for a lighter class of work.

Our foreign *horse hides* come mostly from South America. They are for very various uses, and are consumed largely in the shoe, whip, and saddlery trades.

The hides that are employed in the saddlery and harness trades, are taken almost exclusively from English beasts. Each district in the kingdom supplies hides marked by special features of pattern and growth. Moreover, many districts are marked by special modes of tanning. Owing to these circumstances, a wide scope is afforded to the saddler for the choice of his material. These advantages of selection are not offered to the same extent by other countries; and to these advantages must be attributed much of the acknowledged superiority of the English saddlery. Besides, however, the variety of tannages that are produced, the strong kinds of leather are with us better tanned, and of primer quality than any manufactured abroad.

Before closing our remarks upon this part of our subject, we must say one word upon the skin which is, *par excellence*, that of the saddler—we refer to the hog-skin. None of the pigs of England and Wales are flayed, and we make our acquaintance with the English skin only under the form of "crackling." Our main supply of hog-skin comes from Scotland. Whether our thrifty neighbours are unconscious of the enhanced piquancy which the crackling gives to pork, or whether they prefer to sacrifice those pleasures for the sake of the saddlery trade we leave to the curious to determine. In justice to them, however, we must confess that the skins they supply us with are vastly superior to those furnished by other countries, both in wearing capabilities and beauty of colour.

We have now to examine the various processes that have of late years been introduced into the saddlery trade with the view of bettering and cheapening manufacture. These processes, for the sake of clearness, we classify as follow:—First, those employed in the dressing of leather; second, those employed in cutting out the leather into the shapes required; third, those used for working-up, or manufacturing the shaped pieces into the intended articles.

With the first of these divisions we shall have little to do, as the dressing of leather is a distinct manufacture by itself; and though it is sometimes carried on in the same establishment where saddlery and harness are made, yet far more frequently the two branches of manufacture are entirely separate. We cannot, however, refrain from noticing a machine, which has lately been introduced from America into this country, and is intended for the splitting of tanned hides. By means of this machine a hide can be split (*i.e.*, superficially divided) one or more times, so that, instead, of a single surface of leather we are able to get several surfaces. A great saving is also made in the ready way by which the machine levels the hide, whereby much labour that otherwise would have to be spent in shaving down the hide to the required thickness is avoided. A machine on a similar plan to the one we are now mentioning, has for many years been employed for the splitting of raw, untanned hides; and the novelty consisted in extending the principle that was before only employed for raw hides, to the splitting of hides in the tanned state, and thus giving to the currier a machine that had formerly been used by the tanners only.

Among the appliances used for the cutting out of leather we must first call attention to the "cutting gauge," by means of which straps of varying widths are readily cut out by one instrument. The plan formerly in use for the cutting of straps was as follows:—The compass was first adjusted to the width required for the strap; one leg was then placed against the edge of the leather, whilst the point of the other leg was pressed on the hide, and in this position the compass was drawn the required length, scratching a line, which was afterwards followed by the broad cutting knife. With the "cutting gauge" now adopted it is only necessary to adjust the small blade on a sliding scale (forming part of the instrument), by means of a screw, to the width wanted. The gauge is then ready for use, and any number of straps can be cut off as fast as the knife and hands of the workman can work, and with an accuracy, moreover, that is not to be reached by the old method.

Many pieces of leather, such as girth or brace chapes, for instance, which used to be cut out by means of the knife, are now stamped out with a punch, and the small holes also, which marked where the stitches were to pass through, and which formerly had to be pricked by a separate tool, are now in many instances marked by the same punch, and with the same blow that stamps out the piece of leather to the required form. In several establishments, where the quantities manufactured justify the expenditure, the presses to which the punches are attached are worked by steam power. Many processes, such as blocking, paring, tapering, and rounding leather, formerly performed chiefly by hand, are now effected by appropriate machinery and tools.

We have now to refer to a very ingenious application of the electrotype process. It is often necessary for the saddler to stamp certain impressions upon his leather. This is generally required for the solid flaps of saddles, and is done sometimes, as in the case of our cavalry saddles, to give additional firmness and solidity to the flap, and also to produce a rougher surface, by means of which an increased purchase is afforded to the leg of the rider; and often again, as with cheap saddles, when the expense of a hogskin-covered flap is found too great, to give to the surface of the solid flap an appearance resembling the mark of the hogskin seat, and thus preserve an uniformity that would otherwise be wanting. The flaps of saddles were formerly passed in a wet state, by means of a strong press, over a board on which the dried skin of a shark was nailed. The skins of several species of the shark tribe are covered with sharp, strong points, and are therefore well-suited for the purpose of leather printing. Now, however, in place of the fish skin, a copper plate is employed. This plate is formed by a thick deposition of copper on the surface of a hogskin, and presents, of course, an exact counterpart of every line and mark that is to be found in the skin. The impression given to leather by means of these plates so exactly resembles the surface of the real pigskin, that a practised eye would often fail to detect the difference between the two.

Perhaps the most important process in the manufacture of saddlery is the stitching. The cheapening of a process that forms so important an item of labour has long been attempted by the agency of the sewing machine. But as the work done by this machine lacked the wearing properties of hand-sewing, and as saddlery work must be made specially strong, it was a long time before this defect of the machine could be overcome and it could be introduced with advantage into the trade. Most of these difficulties have now fortunately been conquered, and we find the machine sewing with strongest black waxed threads, through leather as thick even as a quarter of an inch. When the sewings are short, and the fastenings-off frequent, as is the case with the billits of bridles, the machine cannot be employed with advantage.

It would be wearisome to enumerate, but at the same time we ought not to forget, the many processes of manufacture, where, though no apparent change has taken place from the mode in which they were conducted formerly, there has been gradual improvement, and the increased specialisation of tools has enabled the workman to get through these processes far more readily and effectively than heretofore.

From these few remarks it may be inferred that, though machinery has many useful applications in the saddlery trade, yet, from the variableness of the materials used, and the variety of patterns and shapes required, machinery has not that scope which many other trades afford to it.

Whilst the subdivision of labour, the improvement of tools, and the application of machinery, have during late years all steadily combined to reduce the cost of production, we have to remark that during the same period the cost of material has been rising with an almost equal steadiness. In estimating, therefore, the extent to which the improved modes of manufacture have affected the cost of the article, when made up, we have to encounter much difficulty. We can, nevertheless, compare what is paid now for the manufacture of various articles with what was paid at earlier times. From enquiries we have made, extending to most of the branches of the saddlery trade, we consider that a reduction which would roughly average about 15 per cent. has been effected in the cost of labour, as compared with what was expended 20 years ago. From this estimate we have excluded those processes, as sewing, cutting out, and so forth, where the labour is in the main performed by machinery.

The business of the large manufacturing saddlery centres is confined chiefly to the export trade. The modifications of pattern that are found necessary when a private individual orders for his own use, and the special adaptations required to suit his own taste are much better dealt with by the retail dealer than by the wholesale manufacturer. The home trade is confined mainly to what is termed "*saddlers' ironmongery,*" in which is comprised the materials used by the saddler, as well as the iron-work he employs.

With regard to our export trade, we find that the saddlery of most countries is distinguished by special features, depending upon the build of the horses, the climate, and physical condition of the country, the modes of riding and driving employed, and a variety of other circumstances. We can thus account for such strange contrasts as we see, for instance, between the clumsy and uncouth saddle of the stockman of Australia, arranged so as to give him a comfortable seat for the day together, and to carry the whole of his kit, and the delicately-shaped saddle of the East Indian, where every useless ounce of weight is saved, and of which the clear and thin-drawn lines show off the Arab galloway of the rider to every advantage.

A distinguishing feature in our colonial saddlery is its general soundness of make; and our colonists show a manifest predilection for excellence and strength of workmanship rather than for ornamentation or showiness. With our foreign clients, however, the taste runs the other way, and saddlery in which more or less of decoration is introduced seems to be preferred. In many cases, indeed, solidity is sacrificed to show.

The saddlery that is imported into our Colonies is shipped almost entirely from this country, though the Americans make a very light harness known by the name of the "spider," or "buggy"—harness which is largely used at the Cape, and in Australia and China.

In those countries where soundness and durability are required, English saddlery always prevails; but where much ornamentation is asked for, and fanciful shapes, embroidery and varied colours are therefore adopted, we find our French neighbours very close competitors. It is satisfactory to note that, even in those countries where the demand rules for saddlery of a fanciful character, English ideas of soundness and utility are steadily gaining ground, and imports of our saddlery are therefore as steadily increasing.

The best customers of England for saddlery are the Australian colonists, whose rapid development of these colonies, arising from the opening-up of the gold fields, has tended of late years enormously to increase their demand for saddlery; and it is worth while to observe, that in spite of the additional travelling conveniences that are year by year being provided for the colonists, and though they have many first-class coloured manufactures, our trade still improves at a steadily increasing rate. After the Australian Colonies, our next best customers are India and the Cape.

We append a table of our exports of saddlery for the first four months of the last three years. From this table an idea may be gained of the extent of the trade, of the quantities of saddlery that the different countries import, and of the relative ratio of increased consumption :—

	1863.	1864.	1865.
British Possessions in South Africa	£6,974	£8,498	£11,280
British India	£9,471	£11,171	£15,919
Australia	£42,967	£45,334	£70,368
Other countries	£38,817	£30,708	£33,095

Our Continental trade in saddlery has never been of much importance, and with the exception of a few fancy goods, such as solid leather cigar cases, dram bottles, &c., has been in a great measure made up of articles for the use of English residents.

We naturally find that the directions and amounts of our saddlery exports are ruled pretty much by the scale of duties that the various nations impose. With the United States of America, for instance, where heavy protective duties have always been in force, our shipments of saddlery have been but small. A few articles of "small saddlery," such as heads and reins, have been sent, but these were mostly of the commoner qualities. Heavy saddlery, like saddles and harness, were excluded by the heaviness of the duties imposed. The bulk of our exports consisted chiefly of "saddlers' ironmongery"—articles used in the fitting-up of saddles—and which long established habits of manufacture had enabled us to supply the Americans with, in spite of the duties, at a less cost than they could manufacture for themselves.

At an early period of the American war, the already heavy protective duties were augmented some six per cent., and this increase, together with the high rate of exchange, stopped entirely our exports of saddlers' ironmongery. The demand for warlike material, in the shape of accoutrements, leather, and military saddlery, furnished a slight compensation for the stoppage of our regular shipments.

Up to the present time, the direct influence of the French Treaty on the leather trade has been unimportant; but we may reasonably hope that the example of our French neighbours, which is now being followed by many of the other European powers, will gradually improve our Continental trade. In no country is so much attention paid to soundness of work, and the needs of the horse and horseman, as in our own; and English saddlery ought, therefore, to present advantages that, in a state of free trade, would make it sought after by other nations, and especially by those to whom the expenses of forwarding would be least.

The benefits of free trade are shown in a striking manner by free ports. Even in a trade so small as that of saddlery the results are most noteworthy. In Europe, the free port of Hamburg attracts the bulk of our German saddlery trade.

The Danish Island of St. Thomas, in the West Indies, which is a mere rock with a few thousand inhabitants, by being a free port, has become the emporium of many of the islands adjoining, and especially those of Spanish settlement. The shipments of saddlery to this island are of considerable importance.

Besides Birmingham, the neighbouring town of Walsall* does a large trade in saddlery. In fact, the leather, saddlery, and saddlers' ironmongery trades form the staple business of the town. The other noteworthy saddlery centres are London and Glasgow, but in neither of these cities is the business conducted on so large and complete a scale as in Birmingham and Walsall.

Owing to the absence of reliable returns of the workmen employed in the various trades of the town, we cannot accurately state the number supported by the saddlery trade. We should not, however, be far wrong in placing the number actually working at the trade at from 1,200 to 1,500. This of course gives but a bare idea of the gross number of workpeople who are dependent on the existence of the saddlery trade in the town for their employment. If we reckon the number of workmen who are occupied in making saddle-trees, hames, buckles, bits, stirrups, and saddlers' tools, we ought to increase our estimate by at least 1,000. Supposing our lowest estimate of the nett number of people working at the trade to be correct, we should say that the number of 1,200 is made up of 650 men, 150 women, 300 boys, and 100 girls.

The variety of processes employed in the making of saddlery, and the varying amount of skill which these processes require, prevent us from assigning an average wage for the workman connected with the trade. The rule that labour is paid according to the amount of skill required, holds good, of course, in respect to the saddlery trade. A bridle cutter, for instance, whose work is simple as compared with that of the saddler will get from 20*s*. to 30*s*. per week, and we might average his wages at 25*s*. per week. The harness maker would average from 26*s*. to 27*s*. per week. The saddler, according to his ability and despatch, from 25*s*. to 60*s*. Perhaps 40*s.* would be a fair average of his weekly earnings. The women, who are mostly workers with their needle, might average wages of about 9*s.* per week; though where judgment and thought are required, as in the case of those employed by the sewing machine, this average would be considerably exceeded. From these few facts it will be seen that the workpeople are, as a rule, well paid; and as further proof of this we may mention that, in most respectable manufactories, the applications for apprenticeships are far more numerous than can be satisfied by appointments.

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* See the Walsall Trades, *ante* Page 125.

The saddlery trade unquestionably exercises a favourable influence on the social condition of those employed in it. In all its branches the workman has to use some care to adapt his materials to their required ends: and as his material is variable, and the machinery at his disposal serves merely to aid him, and not, as in many other trades, to do the work in his stead, more call is perhaps made upon the individual judgment of the saddler, than is made on that of the workman belonging to most other trades. Even in bridle cutting, which we may look upon as one of the simplest branches of the trade, the workman, in cutting ordinary straps, has to test his leather from time to time, so that the required thickness is neither exceeded nor diminished, and cut past any flaw or cut in the leather that would interfere with the strength or appearance of his work. In the making of a saddle, portmanteau, or set of harness, in addition to care and judgment, the workman also requires a correct and trained eye to maintain the truth, regularity, and soundness of his work. In those saddles, indeed, where embroidery and ornament is introduced, a thoroughly artistic taste has to be added to the qualities mentioned. Many of the saddlers, who turn special attention to this kind of saddle, have had regular art instruction in our School of Design.

The workmen are, as a rule, steady, respectable, and thrifty. Where a sick club belongs to the manufactory at which they work, the men are generally willing subscribers to its funds. Not unfrequently do we find those possessing the borough franchise, and in some instances workmen have invested their savings in a land society, and are living on their own freeholds. As an example of the elegant tastes fostered by some branches of the saddlery trade we may mention that in one large establishment in the town many of the workpeople cultivate music and drawing, and are willing to make sacrifices for the gratification of these tastes, and in some instances the possession of a piano has added to the attractions of home.

During the last fifteen years a gradual increase has taken place in the amount of wages received, though it must be granted that this has been accompanied by a far closer application to work than was formerly customary. A fact not without its importance with respect to the women working at the trade is, that in many cases work can be done with as much advantage at the home as in the factory. Neglect of home duties is thus often avoided.

The only efficient and well organised "*Society*" that we have to notice is connected with the curriers' trade. The Society of this town is part of the Society for the kingdom at large, and is so efficiently organised as to include most of the better class of curriers in the country. The members bind themselves to work by a fixed tariff. When a member is out of work he can claim the assistance of the Society to procure him fresh employment, and the help of a certain weekly payment until he is successful.

Several attempts have been made to form similar societies in connection with other branches of the trade, but hitherto these attempts have met with very equivocal success.

[Whip Making, now an important branch of the saddlery trade, was established in Birmingham as early as 1750; and about 1780 Matthew Deane, of 9, Bull Ring, introduced the "engine," by which labour was lessened, and even children could be employed in the manufacture of hand whips. The manufacture of Spurs and the various articles required for harness and coach and carriage furniture has long employed a very large number of hands. Originally Coach Furniture was forged; but about 1811 the valuable process of Malleable Iron Castings was introduced, and has ever since been used in the production of Coach and Harness work. The Saddlers and Coach Ironmongery trades, and still later the furniture for Railway Carriages, have furnished employment for a very large number of persons, but the full statistics and details of the trades have not been procurable in time for this paper. Birmingham and Walsall (*See ante*) are however the chief seats of these very extensive trades.]—EDITOR.

THE PLATED WARES AND ELECTRO-PLATING TRADES.

BY WILLIAM RYLAND.

It is very difficult to give an account of any subject when the necessary data have been neglected and forgotten, or, where they do remain, are few and insufficient. This is eminently the case with the trade whose early transactions I have undertaken to describe. During the last twenty-five years it has been gradually vanishing from Birmingham. The records of its previous existence are limited to what may be gained from conversation with old hands, or from the recollections of, I believe, the only principal left of those who formerly carried it on. Statistics, with regard to any trade, were very little known or thought of forty years ago, and of this trade in particular the Directories are very deficient in trustworthy information, even as to the number of manufacturers; classing together, as they did, and still do, all the trades where any kind of plating was carried on. So that memory is the only guide in making a selection of those names who were makers of "Plated Wares." It is therefore impossible to give, accurately, the number of manufacturers, or of the hands employed. I should think the numbers of the former never exceeded 40, and if we take an average of 20 to each we shall obtain about 800 hands, and this will include apprentices and foremen.

I have, therefore, confined my remarks to a description of several processes in the business, some of which are still used in the manufacture of "Electro-plate," while others are lost from the necessary changes in the mode of working.

In writing the history of the rise and progress of the plated trade, as formerly carried on in Birmingham, it will be useful to define, as clearly as possible, what is the meaning of the term. There are many articles made and plated here which would not come under the class of goods usually understood as belonging to the plated trade, such as coach harness, forks and spoons, buckles, and other articles, which have been, and are now, plated both with silver and brass. Taken in its ordinary sense, the trade may be defined as the manufacture of all articles used for the table, in dinner, breakfast, coffee, and dessert services, in their endless varieties.

The first manufactory of Plated Goods in Birmingham was, I believe, established at Soho, about the year 1764, by the celebrated Matthew Boulton, whose house was always renowned for the superior quality of the articles they made. It is said that, in order to prove that the "silver mountings," of which all the ornamental parts of the articles were made, were indeed silver, Mr. Boulton used to send a small file with the goods to his customer, that he might test the quality of the metal used. So richly were the articles first made at Soho, that the daily use of forty years has scarcely made them "bleed;" this was, however, owing chiefly to ignorance, for it was not yet discovered how small a quantity of silver could be used in plating. Birmingham was not long in finding this out, and putting it into practice.

The manufacture of "plated ware" had been carried on in Sheffield before any house in Birmingham commenced the trade, and it enjoyed and fairly deserved great fame for the pre-eminence of its work. Still for many years "Soho" maintained its well-earned reputation, and large profits rewarded the enterprise of its founder. At the present time not a vestige of the old place remains. About the year 1796, Mr. Thomason commenced the "plated trade." He had been educated at Soho, and in the quality of the articles he made he rivalled that establishment. From this period the trade rapidly increased, and new firms commenced business. There is no record of the number of houses in the plated trade at this time, but in a Directory published by Chapman in the year 1799 there were platers of all kinds in Birmingham—as many as ninety-six; of these, however, the greater number were coach harness, spur, and buckle makers.*

About the year 1808, Mr. Thomas Ryland entered into partnership with Mr. Waterhouse, who came from Sheffield, and carried on the business under the firm of Waterhouse and Ryland till the expiration of the term of twenty-one years, and these parent houses have supplied from their workshops nearly all the firms which have commenced and carried on the plated trade in Birmingham. The very great amount of detail which existed in the manufacture, and the knowledge which was necessary to economise the working of an expensive material, called for practical men to conduct the business, and the trade being divided into three distinct branches, a workman who had been brought up in either could commence as master in that line to which he had been apprenticed. This, in process of time, very much increased the number of firms, and tended also to great reduction in prices.

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* The Directory of 1780 gives the names of forty-six "Platers;" while that of 1803 gives ninety nine; but adds, "N.B.—Many under the Title Platers, are Coach Harness-makers, Spur-makers, and Buckle-makers."—EDITOR.

The intimate acquaintance which existed between master and men, consequent upon the small number of hands employed in each manufactory, and the great variety of prices which were given for making, prevented any strong combination amongst the men to raise the prices of wages. In the "plated trade," the full term of seven years was required for a youth to learn his business, and it was the custom for the apprentice to obtain a knowledge of every department to which he was bound. In consequence of this the trade could not be rapidly supplied with good workmen, and one of the rules of the trade was that a man should work only at that department to which he had been brought up.

The number of men employed in a large manufactory rarely exceeded 100, including apprentices. As a class, they were about an average with other trades, never setting bodily to work till Tuesday or Wednesday morning. Of course there were always exceptions, and those were generally the men who in time saved money, and began business for themselves. The hours of work were from seven till seven, including one hour for breakfast, one hour for dinner, and half an hour for tea, and work ceased at five o'clock on Saturday afternoon, when the wages were paid. The men generally worked by the piece, and many of them could earn as much as 50*s*. to 55*s*. per week single-handed. If they had an apprentice, towards the close of his term the average gain was much more. For day men the wages ranged from 22*s*. to 40*s*., according to merit in work. This trade has suffered very little from "strikes," owing to the great variety of patterns and the multiplicity of the parts of which many of the articles were composed—some candlesticks having as many as twenty pieces. The prices for making had to be arranged between master and man, and this was done with little difficulty, as there was generally a very good feeling existing between them.

The masters were not very strict in the discipline of their works—"foot ales" and "marriage ales," and "child ales," "walking-stick ales," "change of place ales," "ales charged for making a new article," "journey ales," with numerous others, supplied a constant excuse for extending the five o'clock rest; for "tea" was scarcely known as a beverage in any works. This was often carried on with the master's knowledge, if not with his sanction. The man who paid his "ale" paid 1*s.*; the shopmates putting down 3*d.* each. All this is now changed, at least, in the writer's experience.

The only strike in this trade took place in 1824, when the braziers issued a manifesto signed by forty-one workmen belonging to various manufactories; as a curiosity I give a copy:—

> July 16, 1824.—"We, the undersigned workmen, in silver and plated goods, finding that the prices given at our several manufactories are much inferior to those given at the manufactory of Messrs. Waterhouse and Ryland, who have always given a fair and regular price for all articles they manufacture, are determined (having gained a list of their prices) to work by those, and those alone, in order to do away, as much as lies in our power, with the prejudice that so generally prevails against Birmingham plated goods, and to enable every master to manufacture his goods at an equal advantage, and also to prevent the evils which are fast approaching, owing to the reduction of prices which, if suffered to prevail, must inevitably involve us in misery and distress."

This address had very little effect, a period of bad harvests came, and bad trade soon followed, and the desired "rise" was never obtained. Every man whose name is attached to this document is, I believe, dead; but many of their descendants follow their fathers' occupation. Trade unions had very slight organisation in Birmingham, and were chiefly used as sick societies; and the inducements held out by merchants and factors led to the establishment of numerous "garret masters," as they were commonly called, so that it became very difficult for any set of men to control their fellow-workmen. A very considerable foreign trade was at this time (1824) carried on, the United States imported largely, and the East and West Indies, South America, and Europe were all our customers.

A few women were employed in the manufacture of plated wares, and these always in finishing or burnishing the goods after they had left the hands of the workman. The wages of the women ranged from 7*s.* to 14*s.* per week; but some could gain as much as 18*s.* or 20*s.*, all this being done by piece-work.

The method of plating by the old process was totally different from that now in use; nor could the articles of that period be plated with so small a quantity of silver. It was incumbent on the manufacturer to use a certain quantity of silver, because in the operation of plating care was necessary to provide for the rolling of the metal—a process which required that it should be annealed in its progress through the rolls, as well as for the annealing necessary in "raising" or "stamping" while under the hands of the brazier or stamper. Many articles could not be made unless the plated metal was of a good quality, and the workman could always detect the inferior metal by the colour of the silver after it had been through the fire. If the silver became black he was certain very little was used in the plating. In some large manufactories, the metal was plated on the premises. The principal would deliver to the "plater" the weight of silver he required for each piece of copper, and this was very accurately weighed. About one month's supply was generally made in ingots, and sent to be rolled to the various widths as occasion required. The small makers bought their metal ready for use, large quantities of metal being always kept in stock by the plated-metal dealers. Three or four dealers still plate by the old process, as there is a very large demand for this kind of metal for some trades, but comparatively little for that under consideration.

The weight of copper plated in Birmingham at the present time, is about one hundred tons per annum; of this large quantity, less than one-tenth is consumed by the "plated trade" of which trade there are now in Birmingham nine or ten manufacturers. A very large amount is used for reflectors and the button trade; and London and Sheffield take about equal proportions with Birmingham for plated wares.

The operation of plating was as follows:—An ingot of copper, ordinarily weighing about nine pounds, and which had an alloy of brass of about one-fifth its weight, was first planed by a machine which took a slice of about one-eighth inch thick from the surface which was to receive the silver. This ingot was filed to a perfectly level surface on one or both sides, as the metal was required—"single" or plated on one side only, or "double." When plated on both sides, the ingot of silver, containing about three per cent of alloy, was rolled to the required thickness for the different qualities of metal to be plated. This was cut into suitable lengths, the weight of the piece of silver varying according to the quality, the lowest being about sixteen dwts. for the nine pounds of copper for one side only, and increasing to six or eight ounces—this being very rich metal, and used before the introduction of silver mountings for those parts of the article which required the greatest protection in wear. The piece of silver was about one-eighth of an inch less than the surface of the copper; it was scraped quite clean on the side next to the copper, great care being necessary that every imperfection should be removed; the two bright surfaces were then laid together and "bedded." This was effected by placing a "bedder," or heavy piece of iron, on to the silver, and with a sledge hammer it was struck on an anvil till every part of the two surfaces touched. A strong piece of sheet copper was then laid on the silver to keep it from rising during the process, and also to prevent the wires, which were used to bind the two pieces together, from cutting the outer parts of the silver plate. A solution of borax was then laid round the edges of the silver to act as a flux. The ingot thus prepared was then placed in an oven, in which was a fire made with breezes or fine cokes. The door of the oven had a small hole in the centre, through which the plater could observe when the metal was hot. As soon as he saw a bright line round the edges of the silver he knew that the desired union had been effected; the ingot was then carefully removed from the fire and suffered to cool gradually. When cold, the wires were cut, the copper plate taken away, the edges carefully filed, and the plated ingot was then ready for the roller. In this process it was compressed between two smooth iron rolls, and made in width and strength any size which the manufacturer required, either for "hammering," "raising," "stamping," or "spinning;" and the silver and copper were found perfectly united through the whole length of the metal. The silver mountings used in this trade were, as the term implies, made either of fine silver or of silver with an alloy of copper, making it rather better than standard. The latter produced by far the best work, both as to colour and durability; indeed, fine silver was used only for the commonest kinds of articles. Being so soft it could be used much thinner in the process of stamping.

In the early years of this trade the silver used for mounts was very strong, so thick that many parts were hard or silver-soldered together, and afterwards made solid by pouring soft solder into the hollow parts; but as the trade extended nothing but soft solder was used to join the mounts together. The ornamental dies, in which these mountings were stamped, were made of wrought iron, on the surface of which a piece of steel had been "welded," and in which the pattern was cut by the die-sinkers. This was always a very expensive process, and in large manufactories was the cause of a considerable outlay of capital. The dies in use for strip mounts, or those which were bent round any piece of work, and in which the pattern was repeated to any convenient length, were cut about 4 or 5 inches long, and were so accurately arranged that, in striking a piece of silver 36 inches long, the last part of the impression fitted into the first part of the pattern in the die, and was travelled on till the whole length was completed, thus making one continuous pattern. To prevent the sharp parts of the die cutting the silver, three or four pieces were put together, and then protected on each side with thin strips of copper, and as they gradually proceeded towards completion they were annealed and separated, till they were ready to receive the last blow, when each length of silver was passed along the die. Other ornamental work was cut singly in dies; handles for dishes, &c., being cut so that one die made both sides, and by careful mitreing were finished so that the joining at the seams could not be seen. The dies for all flat and plain work, as well as for many shaped articles, were made of cast iron, and in some manufactories amounted to many tons in weight. When the surface of a cast iron die was "chilled" in casting, a very close and fine texture was produced.

The workmen in a large manufactory were divided into four departments, according to the class of work produced. They were designated in the following manner:—Stampers, Braziers, Pierce-workers, and Candlestick-makers. The men were very careful to keep each operation quite distinct, never allowing any work belonging to one department to be done in any of the others, however important the order might be. The braziers formed the largest class, owing to the nature of their work. In former times almost every article they made was raised by the hammer, and consequently took much more time and labour to complete than those which were put together from the stamp. This operation consisted in forming a tureen, or any other piece of hollow ware for the table, either from a flat piece of metal or a piece of metal soldered into the shape of a cylinder. With wooden mallets the sides of the metal were gradually contracted, by repeated blows on steel "heads," and the full parts were produced by striking the metal inside with a long ended hammer, upon a leather bag filled with sand, which received the blow and prevented the metal from being stretched too far at once. The work required annealing two or three times during the process. After the form was obtained, bright steel hammers were used, to correct any deficiency in the shape; and to produce the fine even surface requisite to its last finish a piece of cloth called smoothing cloth, or black lasting, was tied on to the steel head, and a piece of thin sheet steel was also wired on to the face of the hammer; and by these means all appearance of a blow was completely obliterated from the outer surface, the soft nature of the cloth causing the effect of the blow to appear inside. If the article was required smooth on both sides, the smoothing cloth and steel were removed, and the blow struck on the bright steel head. Another operation which came under this department was "shaping," or the production of ornamental fluting, or patterns of various shapes, of which many of the articles were composed. These shapes were usually produced by filling the body of the work with pitch, and then, with steel punches, tracing the shapes upon it; but in the better kinds of work, and particularly in silver, all this was done with the hammer, no matter how intricate the work might be. In silver work every mark of the hammer was left inside the article, as this was a distinctive mark. Plated goods were always made smooth inside, to prevent the silver from wearing off when in daily use and subject to constant cleaning. All these operations took considerable time to accomplish, and a good workman could do little more than one handsome tureen in a week, the price of which would be 45 or 50 shillings. This price included the "mounting," after the various parts of it had been hammered. In waiters and tea-trays the shapes in the outer part of the plate were generally produced in steel dies — the process of shaping with the hammer being confined to silver work. In all the largest pieces of work, and in many others which had to be engraved with a crest or coat of arms, to prevent the copper from appearing it was the custom to let a shield into the article on which the armorial bearing was cut. This was effected by taking a piece of fine silver, rolled to the thickness and cut to the requisite size, and by placing the sheet of metal which was to receive the shield over a clear fire of coke; the piece of fine silver was placed in the proper position, and rubbed with a steel tool till it adhered to the surface. This was done without the aid of solder, and the operation was called "sweating" it on. The adhesion was perfect, and when hammered smooth it was sometimes impossible to discover it, except by warming the metal, when the difference in colour became apparent. To prevent the necessity of this a small dot was always made in the centre of the shield, so that the engraver was always sure of his mark.

When lower-priced articles for the foreign trade were required in large quantities, plain round articles were "spun" at the lathe. This operation was much quicker than the hammer, and the work could be made of metal of an inferior quality, not requiring more than one annealing, and often done without.

In the operation of "spinning" the copper used was of a finer and softer quality than that used for general work. When the articles had been nicely hammered they were ready for the mounting, and this process was performed either by the man who had prepared it, or by those who did nothing else but mount braziers' work, and in many manufactories this was the rule, as it was found that the change in occupation was not favourable to the production of work so good as when the workman was employed on one class of labour. The mounting being stamped, was given to the mounter, who filled it with soft solder, first covering the outer surface with whiting to prevent the soft solder coming in contact with it. He then filed off the edges, and it was ready to bend round, or to place on any part of the work that required ornament, in order to prevent the edges of the copper being seen when the mount was soldered on. In all the best work an ingenious method was resorted to; the workman took a piece of silver one-sixteenth of an inch wide, and drew it through a very small round hole—made in a piece of steel—thus producing a very fine tube. He then opened the seam through the whole length, and to do this he took a piece of metal of the same thickness as the article he wanted to mount, and inserted it into the seam of the tube at one end, and by drawing the silver along this piece of metal, the tube was opened. He then carefully laid the mounting on to the article, and marked round its outer edge. With a fine point, taking the mount off, he then cut, and afterwards filled the metal all round, slightly within this mark. He then took the thread of silver, as it was called, and bent it into all the inequalities of the edges of the article; the small deficiency in the filing was made up by the thickness of the thread, so that when the mount was put on to be soldered the two edges were level, the mount was then either fastened on with wire, or by small iron cramps, the workman taking care to protect the surface of the mount by putting a piece of thin copper or iron upon it to prevent the pressure of the cramp from injuring the mount. When heated, in soldering, this was done with the blow-pipe;

in very fine and delicate work the blast was produced from the mouth of the workman; but for large work the blow-pipe was attached to a pair of bellows worked by the foot. Resin was used as a flux for the solder, and a clever man would put on a mount in which the slightest trace of solder was imperceptible. This art is now lost, being unnecessary, and I question whether there are many men left who could mount a dish in the old way. In the year 1823, gas was introduced for soldering, this was a great improvement, being much more cleanly, and the heat more easily regulated. The process of hard soldering was done with silver solder, which was usually composed of twenty parts of silver, nine of copper, and three of brass. The flux was a mixture of borax and sandifer, ground very fine, and mixed with water to the consistence of cream, the sandifer being required to prevent the iron wire, with which the parts to be soldered were bound together, from adhering to the metal. The process of hard soldering was chiefly used for the seams of those articles which required "raising" in braziery work, but in other departments it was constantly in use. In hard soldering the workman was very careful not to give too much heat, or he would burn the metal, which was considered to be a disgrace, and if the misfortune occurred frequently to one individual, his name was always associated with it, and was called "so-and-so's mark." The burnt place was repaired by French plating, or rubbing fine leaf-silver on to the damaged part.

Another department was that of "pierce workers," one more easily learned than the braziery, but containing many pieces of work which required considerable skill in fitting and soldering, as almost all articles in this department were made from dies. Here were manufactured all kinds of wire work, epergnes, bread baskets, cruet frames, and numberless other articles. The process of mounting was very much the same, but the class of work was very much smaller. Wages here varied from 24*s*. to 40*s*. per week.

The candlestick makers, as a class, formed the smallest in the manufactory, but afforded good scope for the display of a man's ability. Candelabra branches for the table, chamber and pillar candlesticks, were all made from dies, the arms of the branches being filled with soft solder; and to render the pillar candlestick durable it was filled with resin and sand. The lathe was more used in this department than in any other, and some of the candlestick makers were good "spinners." Some candlesticks were very elaborate, and had as many as sixteen to twenty seams to solder, and these seams were so well joined that a casual observer would not see where it was done. Wages ranged about the same as "pierce workers."

Spinning metal is an art which was, and is, carried on to a very considerable extent, not only for the plated trade, but for many others in which circular bodies, rims, and many shapes were required which could not be produced by dies. England was far behind France in this mode of production, nor do I think to this day that we have ever produced an article of an oval form by the process of spinning. In France comparatively few dies are used in the manufacture of plated articles; the lathe is the machine constantly in operation, and the workmen are exceedingly clever. In consequence of this, almost all the articles made for the table are round or oval, and these are produced by spinning. A French workman will take a flat piece of metal, generally brass, and in a short time will produce an oval cover twenty inches long and eight or nine inches deep, with the edges beautifully lapped over to form the mounting. The mode of work is as follows:—The form of the article required is turned in wood, and is called a chuck; a piece of metal of sufficient size is fixed against this chuck, and held in its place by a short pin from the centre of the metal to the back centre of the lathe. The workman, having supplied grease to the surface of the metal, takes a long piece of boxwood, and presses the metal during the revolution of the lathe as near as he can to the chuck. During this operation he holds another piece of wood with his left hand to the inner side of the metal, and by bringing the two pieces of wood in the same direction from the centre to the outer surface of the metal, he prevents the metal from "puckering." The metal, by compression, soon becomes hard, and requires annealing. When he has softened the metal by this process, he then applies wood or steel tools to the outer surface till he has forced the metal close to the chuck. He then laps over the outer edge, and the article is complete.

The last process in manufacture was the Burnishing, which was always performed by women. The article to be burnished was carefully washed in water, and made quite free from dirt. The burnisher then rubbed that part of the work upon which she commenced with soap, and began, with a bright steel tool, to press backwards and forwards on the metal, dipping the tool constantly into a basin of soap-suds, and making the spaces as long as she conveniently could. By this process she closed the pores of the silver, and produced a bright but not a clear surface, as the steel was not close enough in its texture to prevent a drag on the silver, which left it streaky. This was overcome by the use of the blood-stone burnisher, which, when the article had been "roughed" by the steel, was always used to produce the beautiful surface so requisite in a well-finished piece of work.

The plated trade was carried on successfully till the year 1840, when it was destined to undergo a complete revolution. It had never been a business at which large fortunes were made; one or two manufacturers had retired upon a moderate independence, but the majority worked on till the end of their days. The change which was to consign this trade to oblivion did not arise from want of perseverance on the part of the manufacturers, nor from the negligence of the men, nor from any lack of demand for the production.

Science was called in to work this change, and by the discovery of the means by which silver could be deposited with accuracy and certainty by the aid of galvanism, the whole process hitherto employed in plating was doomed. This did not take place at once, for most manufacturers clung to the belief that the new invention would never succeed, and all were too much interested in the stocks they held to pay much attention to it; whilst one or two saw at a glance that it must supersede the old method of plating.

The whole trade, both here and in Sheffield, set their faces against the innovation, and prophesied the ruin of Messrs. Elkington, who were the discoverers of this valuable process; but little did they know against what indomitable energy and perseverance they had to contend. The platers of London, Sheffield, and Birmingham, did their utmost to crush that which, if successful, they considered would ruin them. But this outcry only acted as a stimulus to the exertions of Messrs. Elkington. The difficulties to be overcome were immense; not the prejudice of the trade only, but the metal which had to be worked, was stubborn, and very little known to the workman. Instead of ductile copper, which he had learned to fashion with the greatest success, he had to contend with a composite metal which, when mixed in due proportions, produced a metal beautiful in colour but very difficult to manipulate. From the first introduction of electro-plating, the metal chosen on account of its near approach in colour to silver, was that which had been extensively employed in the manufacture of spoons, forks, &c., and known under various names, as German Silver, Nickel Silver, Albata, and many others, for each manufacturer tried to invent some new name for that which was really the same thing. The best quality, and that the most difficult to work, was an alloy of 40 parts of copper, 20 parts of spelter, and 20 parts of nickel, and to this mixture the manufacturer still adheres. It was very hard and white, and capable of bearing a fine polish, affording an excellent base for all articles which required plating. The men had great difficulties to contend with in working German Silver, on account of its tendency to crack in the process of annealing. Being composed of three kinds of metal, each varying in its properties, and all containing some foreign substance, as lead, antimony, or arsenic, in their original form, it was at first difficult to get rid of them. The impurity of the nickel was one disturbing cause, nor could it be depended on until it was refined by the wet process. Even to the present time, trials have to be made of the metal before the manufacturer of electro-plate will order it for "raising." The finest quality of copper, the best kind of spelter, and the purest nickel, are indispensable to make a good malleable metal of No. 1 quality. I believe but one manufacturer uses this quality, and not more than two makers of German Silver find it worth their while to produce it for raising purposes.

Mr. Gore's excellent account of the Electro-process is here given :—

> The art of electro-plating is essentially dependent upon the original discovery of the philosopher Volta in the year 1799, that when a pair or series of different metals are brought into contact with a suitable liquid a current of electricity is generated; and also upon the discovery of Messrs. Nicholson & Carlisle, May 2, 1800, Dr. Henry, of Manchester, in the same year, and Hisinger and Berzelius, in 1803, that a current of electricity passed through a conducting liquid, decomposed the ingredients of that liquid, and caused their elements to be set free at the two immersed electric poles. This decomposition is now well known by the term "electrolysis."
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> The earliest recorded instance of the deposition of *metals* by electrolysis appears in a paper by Dr. Wollaston in the *Philosophical Transactions of the Royal Society* of 1801, where it states, that "if a piece of silver in connection with a more positive metal be put into a solution of copper, the silver is coated over with the copper, which coating will stand the operation of burnishing." The next indication of the process, and the first instance of its application to an artistic purpose, appears in a letter from Brugnatelli to Van Mons, in the *Philosophical Magazine*, 1805, stating that Brugnatelli "gilt in a complete manner two large silver medals, by bringing them into communication by means of a steel wire, with the negative pole of a voltaic pile, and keeping them one after the other immersed in ammoniuret of gold, newly made and well saturated."
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> From this period no further notice appears to have been recorded of its application until about the year 1834, when Mr. Henry Bessemer, of Camden Town, electro-deposited "copper on lead castings, so as to produce antique heads in relief for mantel-piece ornaments."—(See *Encyclopædia Britannica*, 8th edition, article Electrotype, page 627).
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> About two years after this the process of electro-plating was again fore-

shadowed by the discovery of Daniell's battery, in which the negative element consisted of a sheet of copper immersed in a solution of sulphate of copper; and Mr. De la Rue in experimenting upon this form of battery records in the *Philosophical Magazine* for 1836, the following passage:—"The copper plate is also covered with a coating of metallic copper, which is continually being deposited; and so perfect is the sheet of copper thus formed, that, being stripped off, it has the counterpart of every scratch of the plate on which it is deposited."

The attention of various experimentalists and inventors appears now to have been directed to the subject, amongst whom were Professor Jacobi, of St. Petersburg, Mr. Thomas Spencer, of Liverpool, and Wm. C. J. Jordan, a book printer, each of whom succeeded in copying metals and engraved copper-plates by the new process. Professor Jacobi was the first to publish his results, of which a notice appeared in the *Athenæum*, May 4, 1839. Immediately upon this Mr. Spencer gave notice, May 8th, to the Liverpool Polytechnic Institution, of his intention to read a paper on the subject; but the paper was not then communicated. Soon after this, June 8th, 1839, a paper was published by Mr. Jordan, in the *London Mechanic's Magazine*, describing the process he employed, and suggesting various applications of it to useful purposes. On the 13th of September of the same year, Mr. Spencer read his postponed paper before the British Association, and illustrated it by various specimens, both of electrotypes and printing from electrotypes. * * * * * * *

At this period, and for several years previously, the attention of several persons was attracted to the subject with the view of making it a profitable speculation. Foremost among these were Messrs. G. R. & H. Elkington, who were engaged commercially in the year 1838 in coating military and other metal ornaments with gold and silver, by immersing them in various solutions of those metals, particularly a boiling solution of carbonate of potash containing dissolved gold. They also employed and patented (July, 1838) a process for coating copper and brass with zinc by means of an electric current generated by a piece of zinc attached to the articles by a wire, and immersed in the metallic solution with them; this was the first patent in which a separate current of electricity was employed for plating purposes.

At the same period (1840), Mr. John Wright, a surgeon of Birmingham, and Mr. Alexander Parkes, an experimentalist in the service of Messrs. Elkington, were constantly engaged in electro-deposition experiments to obtain with silver and gold similar results to those obtained by Jacobi and Spencer with copper, viz., *thick* deposits of *firm* coherent metal of *good colour;* but without success. At this juncture Mr. Wright met with a passage in Scheele's "Chemical Essay" (pages 405 and 406), which soon proved of the highest degree of importance to the commercial success of the art. Speaking of the solubility of the oxides and cyanides of gold, silver, and copper, it says, "If after these calces (*i.e.*, the cyanides of gold and silver) have been precipitated, a sufficient quantity of the precipitating liquor be added in order to re-dissolve them, the solution remains clear in the open air, and in this state the aerial acid (*i.e.*, carbonic acid of the air) does not precipitate the metallic calx."

This suggested to Mr. Wright the probable suitability of the *cyanides* of gold and silver for electro-plating, and he immediately took a solution composed of chloride of silver dissolved in aqueous ferrocyanide of potassium for the purpose, and quickly succeeded in obtaining what had never been obtained before, a *thick* deposit of *firm* and *white* silver by electrolytic action; in all previous trials the coating of silver had either been very *thin* or in a state of dark-coloured loose powder, completely useless for practical purposes. It was about a month after this before the actual cyanide of silver and potassium, as now used, was employed by Mr. Wright for electro silver-plating.

At this period Messrs. Elkington were patenting a process for coating articles of copper with silver by a method of fusion, also by means of a solution of "oxide of silver in pure ammonia," and Mr. Wright, submitting his results to them, had his process embodied in their patent, March 25, 1840. This patent has proved the basis of all successful electro-plating, because it included the solutions of alkaline cyanides, the only known liquids that fulfil all the necessary conditions.

The chief conditions of success had now been all attained, but there still remained many smaller difficulties to be overcome. In some instances the deposited silver would rise in blisters, or all peel off, on the application of the burnishing tool. In other cases the deposited metal occasionally assumed objectionable colours, frequently brown, yellow, or grey; and in other instances, instead of being even and smooth, it was covered with asperites, nodules, or vertical grooves. Great difficulty was also experienced in coating articles of iron, steel, tin, lead, Britannia metal, &c., so as to secure perfect adhesion—and particularly in coating, of a uniform colour, articles, the different parts of which were formed of several of these metals, or had been united by different kinds of solder. These and many other technical difficulties were chiefly overcome in the manufactory of Messrs. Elkington by the ability of Messrs. Fearn, Parkes, and Millward, with the aid of the large resources of that establishment. A dispute also arose between Messrs. Elkington and Ruolz (a French electro-depositor, who had obtained a knowledge of the process, and taken out a patent in France a short time before Messrs. Elkington), which after a trial at law was finally settled by a compromise between Messrs. Ruolz and the original patentees of the cyanide solution for the use of the process. Great opposition was also experienced from the manufacturers of Sheffield wares, and from shopkeepers who sold plated goods, to the introduction of the new articles; and in consequence of these various difficulties the process was not remunerative to Messrs. Elkington for at least seven years.

The next event of importance in the history of electro-plating was the employment of electricity from magnets, instead of from a voltaic battery, to plating purposes; and a magneto-electric machine for this purpose was patented by J. S. Wolrich, of Birmingham, August, 1842. This machine has been used by Messrs. Elkington, Prime, Fearn, and others in Birmingham, and some manufacturers in Sheffield, but chiefly by Mr. Fearn, who posseses several beautiful magneto-machines for electro-gilding and brassing. The large machine of Messrs. Elkington and Company is also in use. The construction and action of these machines is precisely similar to that of Mr. Holmes', which was shown in the machinery department of the Exhibition, and employed for producing an electric light.

Five years now elapsed before any further development of importance in electro-deposition occurred, and this consisted of what is termed bright "plating." In the ordinary course of electro-plating, the deposited silver has a snow-white or frost-like appearance, and requires to be burnished in order to make it bright. The process of burnishing is tedious, and oft-times very awkard to perform on account of the peculiar shapes of the articles, and consequently it adds considerably to the expense. To remedy this it was desirable that the silver should be deposited in a bright or polished condition instead of the usual dull white, and a little circumstance occurred which led to this desirable result. Some wax moulds, partly saturated with bisulphide of carbon, were occasionally immersed in the silver-plating vats at Messrs. Elkington's establishment, for the purpose of receiving a coating of silver; and it was observed by Mr. Millward, the silver depositor, that whenever these moulds were in the vat the silver deposited on the articles near them acquired a bright appearance. This led to experiments upon the influence of adding small quantities of bisulphide of carbon to the ordinary silver-plating solution, and it was soon found that this substance produced the desired effect. At this period the secret escaped, and in consequence thereof a patent was taken out, March, 1847, in the joint names of Mr. Millward and a person named Lyons, who had acquired a knowledge of the secret. The process is now in general and extensive use, and although it does not cause the silver to be deposited exactly in a burnished state, yet it materially reduces the amount of polishing required, and gives a greater scope for the exercise of taste in ornamenting the silver surface.

Many other improvements of a less extensive character have from time to time been effected in the various branches of the art, and most of them, though not all, were developed by the intelligence of depositors in the manufactory of Messrs. Elkington, aided by the unexampled resources of that enterprising firm. One of these improvements consisted in coating iron and steel with copper, and is effected by means of a solution of cyanide of copper and potassium; and another consisted in making the silver adhere firmly to iron, steel, and Britannia metal, which could not in the early days of electro-plating be effected.

The process of silver-plating as at present practised, may be thus briefly described:—A weighed quantity of pure silver in small fragments is taken (allowing about one or two ounces of silver for each gallon of solution required) and dissolved by gradual addition of the fragments, in a warm mixture of four parts of pure nitric acid and one part of distilled water, care being taken not to employ more acid liquid than will dissolve all the silver. The portion of pure undiluted acid required is generally about one and three-quarter ounces to each ounce of silver, but it varies with the strength of the acid.

The solution of silver is now largely diluted with distilled water, and a moderately strong solution of cyanide of potassium added to it in portions at a time with stirring, and a subsidence between each addition, as long as a white precipitate (which is cyanide of silver) is produced; it is very particular that this point is just attained and not passed, otherwise some silver will remain in solution and may be lost; if this point is passed, as may be known by the supernatant liquid becoming transparent and slightly brown, a careful addition of some diluted nitrate of silver solution will bring it back again. Each ounce of silver requires nearly half an ounce of cyanide of potassium of the ordinary quality to precipitate it, but this proportion varies greatly on account of the great variation in the commercial quality of that salt.

After subsidence of the precipitate, the clear liquid is filtered through calico, the sediment also drained upon the filter, and washed five or six times with copious quantities of spring water. A small quantity of hydrochloric acid is added to the whole of the liquid and wash-waters to precipitate any silver that may remain; this precipitate is collected, and the liquid thrown away.

The wet contents of the filter are now dissolved by constant stirring in a strong solution of cyanide of potassium, using no more cyanide than is necessary to dissolve it, and noting how much has been consumed; whatever that amount may be, an equal additional amount should now be added and dissolved to constitute what is termed "free" cyanide. If the cyanide of potassium employed is of the ordinary commercial quality, each ounce of silver used will require about two or two-and-a-half ounces of it to re-dissolve the precipitate of cyanide of silver. The solution now only requires to be diluted to the given strength of silver per gallon, and filtered, when it is ready for use. If the solution is required for bright plating, several pints of it are put into a bottle with a few ounces of bisulphide of carbon and shaken occasionally during twenty-four hours; the supernatant liquid is then added daily, or every two days, in portions to the plating liquid, in the proportion of about one ounce of the former to thirty gallons of the latter.

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For the details of the various processes of coating metals and other bodies with gold, copper, brass, &c., and the various methods of electro-plate ornamentation, the reader is referred to the published books on the subject. All articles before being plated require to be made *perfectly* clean; and the various processes of cleaning, which consist generally of dipping in acids, or scouring with revolving wire brushes, &c., oftentimes occupy more time than the entire process of plating. To further ensure adhesion of the deposited silver, the cleaned articles are momentarily dipped into a very dilute solution of nitrate of mercury or double cyanide of mercury and potassium, and then into water, immediately before immersion in the plating vat. It is also essential to success that all the points of contact of the metals where the electricity has to pass between the battery and the vat, &c., be kept perfectly clean, and closely together. The extreme thinness of the coating of silver which is sometimes put upon articles may be judged of by the fact, that iron snuffers are sometimes completely coated with silver for twopence-halfpenny per pair.

At the commencement of the electro-plated trade, not only had Messrs. Elkington to contend against the difficulties already mentioned, but they had a more serious one in the prices at which articles in the old trade were sold; and they had to produce the improved work at prices very little in advance of these, and this with a metal which cost 2*s.* 6*d.* per lb. instead of 1*s.*; silver at 12*s.* per oz., including the cost of depositing, instead of 5*s.* 6*d.*, and the wages of the workmen, who at first demanded one-third more than they were receiving for the old plated wares. As a matter of course, the business for some years was carried on at a serious loss in some departments, whilst by the introduction of "casting," which had never yet been applied to the trade, some advantage was gained. Subsequently, by the division of labour and the employment of machinery, many of these difficulties have been overcome, and a good workman can now produce more work in a given time than he could by the old process. We have seen that the old method of proceeding was, by first plating the copper, and then by means of various manipulations, producing an article which was finished, all but burnishing, when it left the hands of the workman. Electro-plating has reversed this, and that which was formerly the first is now the last operation; for it is necessary that the article should be finished and nicely polished before it receives its coat of silver. There is great advantage to the manufacturer in this, as his rough stock is not so costly, being made in German silver, and plated only, as the goods are required for orders. In work made from the best quality of German silver, very little change takes place in the metal by lying in stock; but in that made with common metal, it sometimes happens that from exposure to the atmosphere, and particularly where gas is consumed, the metal seems to be disintegrated, and it becomes so rotten that many articles fall to pieces when being prepared for plating.

The rapid advance made by Birmingham in fine art productions since the introduction of this valuable discovery, has been marvellous, and has given scope to the talent of a class of artisans in designing, modelling, and chasing, which before had no existence. The effect of the training, for this kind of work, has been of great advantage to the moral standing of the workman. The occupation is pleasant, the labour light, cleanly, and remunerative, and the impression produced on the mind and heart, by the study of fine forms of decoration carried out in the highest character of workmanship, lead the artist captive, and prevent him from falling into low pursuits, which would not only degrade him as a man, but destroy his ability to produce the requisite effects in his work. The means of adding to the embellishment of our houses has wonderfully increased. We are now able to produce works by electro-plating, equal in appearance to the most elaborate silver; nor does there appear to be any limit to the designs which are constantly in demand.

Under the old process all ornamental work was produced by the die sinker, and as a consequence, every portion of the die had to be so arrayed that the work would "leave" it. The foliage, if attempted, was clumsy, the stems and leaves, being massed together, were heavy and shapeless, and the human form was never attempted. Now, by the aid of modelling, casting, and electro-depositing, the most delicate forms are capable of being applied by the manufacturer, and the human figure stands out pre-eminently as a great acquisition to the plater's art. The graceful forms of animals, birds, and insects are seized upon by the modeller, and made subservient to his productions.

The manufacture of the various articles for electro-plating is performed by the same classes of workmen who were employed in the old trade, but the division into separate departments is not so strictly observed, and the manipulations are not exactly the same. Owing to the new mode of plating there is no occasion to protect the edges of the work by the silver thread, all the edges being filed and polished. Soft solder is almost banished, and silver solder has taken its place in putting on the mountings, and these mountings are all filled with brass instead of lead and tin. This mode of work renders the article more durable, and, if well plated, will last in domestic use for twenty years; and then, if the silver be worn off, the goods can be re-plated. Owing to this change from soft to silver solder, the workman is more exposed to the fumes and heat of gas, by which most of the soldering is performed; and this part of the labour is more trying to the health than in former years.* It will give some idea of the vast increase of the trade to mention that, in the year 1823, gas was introduced into the plated trade by Waterhouse and and Ryland, their consumption in 1824 was 50,800 feet, at a cost of 15*s.* per 1,000 feet. In the year 1864, after a period of forty years, the consumption of gas, in the works of Messrs. Elkington, was upwards of 4,000,000 feet, at a cost of 2*s.* 8*d.* per 1,000 feet. In ten years after the introduction of electro-plating, the latter firm had erected spacious premises, and found constant employment, for upwards of 500 hands.* I have described the manufacture of the articles, by permission, up to the process of plating, and here I have, by permission, extracted from an article written by Mr. Gore, for the "Practical Mechanics' Journal," his account of the first rise of electro-deposition in Birmingham, and also his description of the manner of preparing the silver solution, and the battery by which the work is accomplished.

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* In the manufactory of Messrs. Elkington, separate rooms are set apart for soldering purposes, so that the air in the workshops is not affected by the consumption of gas, this adds very materially to the comfort of those employed.

The following system is adopted in the works of Messrs. Elkington and Co.:—The work being finished and prepared for plating, it is taken to the plating room, when each article is carefully weighed and entered in a book, with the amount of silver it is intended to put on it placed against it. The first process is to thoroughly clean it. This is effected by boiling the article in a solution of caustic potash, in order to remove every particle of grease that may have been left by the polisher. It is then scoured with sand and dried in saw-dust; a piece of copper wire is then fastened to it and it is immersed in dipping acid, very quickly, to produce a clean bright surface, and afterwards washed in clean water. It is then plunged into a solution of cyanide of mercury, to prevent any oxidation, as well as to secure a perfect adhesion in the plating, and at once taken to the plating vat. This vat is divided by plates of silver into regular compartments, and the articles are suspended on brass rods with copper wire, and so arranged as to expose an equal amount of surface, in each compartment, to receive the deposit of silver. The operation of plating is so nicely regulated, that the rate at which the silver is being deposited is correctly known, and the large amount of 24 ounces per hour is deposited, perfectly smooth and extremely hard. This, with the thickness of silver, accounts for the great durability of the articles manufactured by Messrs. Elkington. There are several large vats in use, so that some idea may be formed of the large amount of silver deposited in one day. When the article has been in the vat a sufficient length of time it is taken out, rinsed in cold water, and dried; after that it is carefully weighed, and the exact amount of silver on the article is at once seen and registered. In addition to the ordinary batteries used in plating, a very large magneto-electric machine is in constant work.

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* I suppose there may be, at the present time, in Birmingham, 400 or 500 more hands employed in this trade, exclusive of those employed in the manufacture of spoons, forks, &c., &c., but of this I cannot speak with any degree of certainty.

After the work has received its proportion of silver it is forwarded to the finishing department, and here it may be stated that the less the quantity of silver deposited on the article the more easily is it finished. The surface of the metal, before plating, being made very smooth by polishing, a small deposit of silver is easily burnished, as done by the old trade; but when a thick coat of silver is put on the surface becomes rougher, and will not bear a high polish until the article has been hammered all over. For though to the casual observer the silver appears quite smooth, yet, when put to the test of the burnish, it is found to be so uneven that great force is necessary to make the surface take the beautiful polish which was so easily produced by the blood stone. The workman, therefore, is obliged to close all the pores, and make the surface smooth with the hammer; and this has another effect, which is of great advantage to the article, in making the silver much harder, and consequently adding something to the wear. When the "bright hammerer" has done his work the goods are sent to be either burnished, as before described, or "handed up." This latter process is performed in the same manner that the silversmith adopts in colouring his work, and is done by the hand, with rouge or fine oxide of iron. All best work is coloured after it is burnished, as the effect is much clearer and the silver made much smoother.

Having now described the leading features of manufacture, in both the old and new trade, I cannot conclude without expressing my firm conviction, that a well-made and a well-plated article, manufactured by the electro-process, is a far better production than those made by the old method of plating. On the other hand, I am as much convinced that a poor electro article is far inferior to the worst class of work manufactured under the old system.

[The electro-plating trade has many sub-divisions, sometimes united in one establishment, but often carried on as almost separate trades. The modern fashion, which has replaced the old three-prong steel fork of Sheffield origin by German silver and electro-plated forks, has created an enormous demand, and a large number of persons are employed almost exclusively in the manufacture of Spoons and Forks. For the following details the Editor is indebted to Mr. A. S. Paterson, whose report has been condensed in consequence of the chief facts having been already given in Mr. Ryland's review of the old "Plated Wares" trade:—The first great improvement in the manufacture of spoons and forks was the introduction, by the late Mr. Askin, of German Silver, as the material of which to make them. It is a metal formed of a mixture of nickel, copper, and spelter. The Chinese have been in the habit of using it for many ages, and at the time Mr. Askin introduced it into this country the Germans were in the habit of using a considerable quantity of it, but of a very inferior quality. Their want of care in refining the nickel still prevents their making an article nearly equal to the English in the whiteness of its colour. The present process of manufacture is as follows:—Firstly, the metals have to be mixed in the crucible to form "German Silver," which is cast into flat ingots. This is generally done by the "metal dealer," who does not manufacture articles. The ingots are then rolled to a suitable thickness, and then cut into narrow strips. These strips are again rolled at the ends only—one end for the top or handle, which is required to be wider and thinner than the middle or stail, and the other end still wider and thinner, for the bowl or prongs. They are then cut out, with a pair of steel tools, the size and shape required. Then, if a fork, the spaces between the prongs are pierced; and if a spoon, the bowl is stamped or pressed into form. The surface is levelled with the file, and they are afterwards ornamented by means of dies. They now require to be polished, which is done with sand, applied with a wooden wheel covered with leather and revolving by steam power. The best sand for the purpose is found on the bed of the river Trent. To give them a still higher polish quick-lime is used, a quality procured in the neighbourhood of Sheffield being preferred. If not intended to be plated the article is now finished, and only requires to be cleaned and wrapped up for sale. But if intended to be plated, they are first boiled in a solution of potash or strong soda, to remove all grease, and then swilled in acid to remove the oxide due to the copper in their composition. They are now ready for immersion in the bath of silver solution, where they are left for several hours, the current of electricity constantly passing through them, and uniformly depositing a continuous and constantly thickening coating of silver. The length of time which they are left in the bath depends on the quality it is required to make, all manufacturers making a variety of qualities. The quality is proved by weighing the article both before and after plating, the difference in the weight showing the quantity of silver with which they are plated. After plating, they require to be again polished with a preparation of rotten-stone or lime, the highest gloss being given with rouge, applied with the palm of the hand. Besides spoons and forks, there are many other articles usually classed with them, *viz.:* nutcrackers, knife-rests, fish eating knives, dessert knives and forks, &c. Some idea may be formed of the quantity of these odd articles manufactured, from the fact that there are probably at least thirty families supported in this town by the manufacture of *plated* nutcrackers alone—the orders for this article are over 1,500 dozen pairs per annum; but are very much affected by the crop of nuts—a good season often doubling the demand. The sale of unplated spoons and forks is very much larger than that of plated; and the qualities, with respect to thickness, workmanship, and material used, are very various—a great number (especially for export) being made of brass, and boiled in a solution of tin, to whiten the surface. . The manufacture of spoons and forks probably finds employment for several hundreds of hands, the greater portion of whom are men and boys, earning fair but not very high wages. Women and girls are employed in the polishing, both before and after plating; also for the handing, washing, wiping, and wrapping-up of the work.]—EDITOR.

THE BIRMINGHAM ASSAY OFFICE.

By ARTHUR RYLAND.

The history of the Assay Office, its establishment, growth, and present condition, afford an important illustration of the rise and progress of the silversmith and jewellery trades in Birmingham. Before entering upon this history it may be well to explain somewhat of the object and procedure of assay offices generally.

Whatever may have been the motive for the original establishment of this institution, it is now regarded as having for its object the prevention of frauds in the sale of gold and silver wares. Every purchaser may, by an examination of the assay marks, ascertain whether what he buys is of the standard represented by the seller.

The marks are also important as aids to the discovery of frauds sometimes committed by the transposition of marks, or the addition of base metal to assayed articles.

Originally, one mark only, that of the *Leopard's head*, was used to testify that the ware bearing it had passed the ordeal of assay. Now, five marks are required by law; these are commonly called hall marks, and are as follow :—

1. *The Maker's Initials.* This mark is stamped on each article by the maker before the work is sent to be assayed. No work is received at the office from any person who has not registered there his name, place of business, and initial mark; and with every parcel of work the maker is required to send a note, describing its character, weight, and standard.
2. *Standard Marks.* These marks are as follow :—

For gold of	22 carats*	....	A Crown and the figures 22.
	18 ,,	....	A Crown and the figures 18.
	15 ,,	... † ...	15 and ·625.
	12 ,,	... † ...	12 and ·5.
	9 ,,	... † ...	9 and ·375.

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*In the gold standards, the figures represent the proportion of fine gold in an ounce of 24 carats. In the silver standards, the figures represent the proportion of fine silver in a lb. of 12 ounces.

† It may be interesting to observe that the decimal notation used in these lower, and recently introduced standards, was introduced by the Government at the request of the *Decimal Coinage Association.*

For silver of 11 oz. 10 dwts. ... (This standard is seldom, if ever, used).	Lion's head erased, and Britannia, except at Birmingham and Sheffield, and there, Britannia alone.
For silver of 11 oz. 2 dwts.	Lion passant.
3. *The Duty Mark*	Invariably the Sovereign's head.
4. *The Date Mark*........	A variable letter selected by each Office, and changed every year.
5. *The Office Mark*...........	To denote where the Assay was made. In Birmingham, it is an *Anchor*.

From every article sent to be assayed a portion of the metal is scraped off, to enable the Master to test the quality of the gold or silver of which such articles are made. The scrapings are technically called the *diet*. And here must be noticed a peculiarity belonging to the offices at *Birmingham* and *Sheffield*, which should give to their assays a higher value than those of any other office. The assays made at these two offices are tested every year by the *Master of the Mint*, and if any of them are lower than the standard the Assay Master is liable to a penalty of £200, and is rendered incapable of acting again as an assayer at that office.* In order to provide the means for this trial such of the scrapings as are not used by the Assay Master for his assays are carefully kept, each manufacturer's distinct by themselves; and in the different standards from those which represent other manufacturers, except in those few cases in which a very small quantity is received from any maker, these exceptional instances form one parcel by themselves. And thus carefully preserved, under strict regulations by the Wardens and Assay Masters, the diet is at least once a year sent to her Majesty's Mint, where, with formalities similar to those for the trial of the coinage, it is tested by the Master of the Mint. And hitherto, to the honour of the Assay Masters of Birmingham, their work has passed through the ordeal without any shortcomings.

The diet, after undergoing the trial at the Mint, is returned to the Assay Office, and is sold. The money so produced goes with the fees received for marking the goods to form the fund out of which the expenses of the establishment, and of the prosecutions of offenders, are defrayed. Any surplus of income at Birmingham is invested in consols, and the statute requires that when it reaches £3,000 the charges for marking shall be lowered until it is reduced to £1,000, when the higher charges may be resumed.

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* The other provincial offices are liable to the same ordeal if required by the Lord Chancellor; but in practice, the statute relating to it is a dead letter. Birmingham is the only office whose gold assays are thus tested; and that and Sheffield the only offices whose silver assays undergo the trial.

The articles which the law requires to be assayed are marked, and all those which are made of gold or silver, except watch cases, rings, not being wedding or mourning rings, and certain small things which were deemed by the Legislature to be too small to receive the marks without damage. And all articles so required to be assayed are liable to the payment of a duty. This duty the Assay Office authorities are required to collect. The imposition of a duty is much later than the institution of Assay Offices. In the year 1800, the first statute relating to the assaying and marking of gold and silver wares was passed, and antecedently to that statute the London Goldsmiths' Company had such an office, and the first duty was imposed in the year 1720.

There are seven Assay Offices in England, two in Scotland, and one in Ireland. Those in England are at London, Birmingham, Chester, Exeter, Newcastle-on-Tyne, Sheffield, and York. Formerly there were offices at Bristol, Coventry, Lincoln, Norwich, and Salisbury.

The Assay Office in Birmingham was established in 1773. Previously to that time all gold and silver goods made in Birmingham had to be sent either to London or Chester to be assayed and marked. The Act of Parliament establishing the office was the result of petitions from manufacturers in Sheffield and Birmingham. The petition from Sheffield set forth that a manufacture had of late years begun within the town and neighbourhood, and that much inconvenience was occasioned by having to send the goods to London to be assayed and marked. This petition was presented on 1st February, 1773. On the following day, a petition was presented to the House of Commons from Matthew Boulton, on behalf of himself and the rest of the manufacturers of silver wares in Birmingham. In the petition, after noticing the petition from Sheffield, it is stated that the petitioners, and several others, were engaged in a manufacture of wrought silver plate of different kinds at the town of Birmingham, which might be considerably extended and improved, in case an Assay Office was established in the town; but that the inconvenience they laboured under in sending their goods to Chester, being upwards of 70 miles distant from Birmingham, and the nearest town where any office for assaying plate was established, was attended with an expense, hazard, and delay greatly prejudicial to the manufacture, and obstructing all such improvements as might otherwise extend the sale thereof, both at home and in foreign parts. And the petitioners prayed that if, upon examination, it should be thought expedient to establish an Assay Office at Sheffield, the like provision might be made for the town of Birmingham, which was exactly in the same circumstances. The application thus made was strenuously opposed by the Goldsmiths' Company, of London. Petitions from that body, and also by certain individual goldsmiths and silversmiths in London, were presented, objecting to the establishment of Assay Offices at Birmingham and Sheffield; and so earnest was the opposition, that the Company appeared by Counsel, not only before the Committee, but also, which was unusual, at the Bar of the House on the bringing up of the report.

Their grounds of opposition were, that the then existing country Assay Offices (namely), those at Exeter, Chester, and Newcastle-on-Tyne, were not well conducted, and that several persons in Birmingham and Sheffield had, "of late years, not only plated or covered with silver, many wares and manufactures made of base metal; but some of them had even marked the same with marks resembling those appointed for real silver plate;" and that Birmingham and Sheffield were not corporate towns, and had not a company of goldsmiths, and that there were very few real goldsmiths or silversmiths in either of those towns.

In support of these allegations, several witnesses were examined; but they failed in convincing the Committee that the opposition ought to prevail. For our present purpose, it may be interesting to notice, as an evidence of the state of the trade in Birmingham in 1773, the following:—It appeared from the London evidence, that five persons from Birmingham had entered their marks at Goldsmiths' Hall Assay Office; but, in the report of another Parliamentary Committee in the same year, the following names are found as entered at 16, London Hall:—Thomas Carter, plate worker, Edmund-street; Thos. Carter, smallworker, Edmund-street; Benjamin Cooper, smallworker; Robert Fox, spoon maker; John Gimblett and William Vale, watch-case makers; Edward Gratrix, buckle maker; Mark Hobner, gold worker; James Jackson, smallworker; Daniel Palmer, buckle maker; Reuben Parker, watch-case maker; John Smith, smallworker; John Turner plate worker; and James Wright, plate worker. It is also interesting to remark that another part of the same return from the London Goldsmiths' Company shows that, although during the preceding year, a quantity of more than five pounds weight of gold work, and upwards of a thousand pounds weight of silver work belonging to 147 London manufacturers had been broken by the Assay Masters, as not being of proper standard, there was not a single instance of bad work from Birmingham.

In support of the Birmingham petition only one witness was called, Mr. Samuel Garbit, he spoke to the kind of work done by Mr. Matthew Boulton. He said the articles made by him were tureens, epergnes, candlesticks, vases, coffee pots, and many ornamental utensils as well solid silver as plated, both for London and the country market: that Mr. Boulton began the manufacture of silver plate about 1766; there were about forty other manufacturers of plate in Birmingham, who had licenses. Mr. Boulton sent plate to Chester to be assayed and marked, which occasioned delay, uncertainty, and the goods were often damaged. The workmen in the fire arms' trade, an important trade in Birmingham, found it more convenient to get the ornaments ready manufactured from London, although they could make them at half the price in the country, and from the want of an Assay Office, the manufacture of buckles, a great trade in Birmingham, was checked. In this business above 5,000 workmen were employed. The patterns had to be sent to London, and the manufacturers considered that they would be thus discovered, and if this inconvenience were removed by the establishment of an Assay Office the manufacture of silver plate, particularly of buckles, would be greatly increased. He further states that Mr. Boulton had many thousand dies, which he could make use of in different parts of a silver manufactory, but did not, on account of the inconvenience of assaying, and that there were many other manufacturers who would avail themselves of the present tools in manufacturing silver plate, if it were not for the same inconvenience. The foregoing evidence is taken from the *Journals of the House of Commons*, where the report of Mr. Skipwith, M.P., on the petitions before mentioned, appears in extenso. Contemporaneously with the enquiry of Mr. Skipwith's committee an enquiry before another committee was made into the working of the Assay Offices in London, Exeter, York, Bristol, Chester, Norwich, and Newcastle-upon-Tyne, before which committee Birmingham and Sheffield were also charged with committing frauds in the manufacture of silver plate. The committee printed the evidence in extenso without comment. This evidence and that reported by Mr. Skipwith failed to convince the House that Birmingham and Sheffield were unworthy of Assay Offices. On the 27th May, 1773, an Act was passed authorising the establishment of Assay Offices for silver work at Birmingham and Sheffield. To each office was assigned a district of twenty miles round the town, and all silver wares made within that area were required, under heavy penalties, to be assayed and marked at the local Assay Office. Each office was placed under the management of a Board of Guardians, that at Birmingham was incorporated under the style of "*The Guardians of the Standard of Wrought Plate in Birmingham.*" The provisions of this Act, in reference to the powers of the Guardians and the duties of dealers and manufacturers of silver wares, were similar to those of the 12th George II., which regulated the other provincial Assay Offices, and the London Goldsmiths' Hall.

Additional powers were conferred upon the Birmingham Assay Office by a local Act obtained by the Guardians in 1824. It authorised the Guardians to assay gold as well as silver wares, extended their district from 20 to 30 miles round the town, and empowered the Guardians to purchase land and buildings for their office. The exclusive right of assaying gold and silver wares made within the prescribed district was abolished in 1854, in which year an Act was passed, chiefly upon the representations of the watch makers in Coventry, enacting that workers or dealers in gold or silver might register their names and marks, and send their wares to be assayed at such office as they chose, without incurring the penalties in the former Acts.

In the same year of 1854 other and more important changes were made. The standard of gold in England, then 18 carats, being much higher than that used in America for watch-cases, the exportation of watch-cases was greatly impeded; one-half, at least, of the watch movements made in Coventry were exported to the United States of North America without cases, and were there set in cases manufactured in America.

These American-cased watches were offered for sale in other foreign markets at lower prices than English goods of the same appearance could be made in England. And further, in France and Switzerland watches were made of a standard lower than 18 carats, and, consequently, English merchants could not successfully compete in the sale of gold watches abroad. These facts were brought under the notice of the Guardians by the Coventry watch manufacturers, and by some of the leading merchants and manufacturers in Birmingham, and the Guardians at once applied to Government to bring in a bill to legalise a lower standard for watch-cases. This suggestion created a desire on the part of the jewellers to participate in the use of such lower standards as might be introduced. So long as the standard was so much above the quality of gold used by jewellers it was a matter of no consequence, but as it was about to be reduced to the quality in use by them, they suggested to the Guardians that many of their goods would be sent to be assayed if they could be exempted from the payment of duty which would thereby become payable, and they requested the Guardians to get such exemption provided for in the Government Bill. Both objects were attained. The Act of Parliament before referred to empowered the Queen to introduce, by Order in Council, lower standards for wrought gold, and also enacted that gold wares not then liable to be assayed and marked might be assayed and marked without thereby becoming chargeable with duty.

This Act passed in August, 1854, and on the 22nd December, 1854, an Order in Council was issued, authorising three additional standards of 15, 12, and 9 carats. The introduction of the lower standards, and the opportunity of having jewellery goods assayed and marked, has had a remarkable effect upon the trade. The marks are so highly prized by the public, that it has become a necessity with the jewellers to pass all their best goods through the Assay Offices.

Previously to the introduction of the lower standards, the greatest quantity of gold assayed in any one year was 4,419 ounces, and this was an exceptionally large amount. From 1855 to 1865 the amount has increased every year, and between June, 1864, and July, 1865, it reached to 31,960 ounces.

The following figures appear in a paper laid before a Committee of the House of Commons, in 1856, by Mr. Westwood, the Assay Master, in his evidence relative to the Assay Office at Birmingham :—

WEIGHT OF GOLD ASSAYED AND MARKED AT BIRMINGHAM.

	Subject to duty.			Not subject to duty.		
	oz.	dwt.	grs.	oz.	dwt.	grs.
1851......	2,153	3	0	1,149	18	15
1852......	2,597	1	9	904	9	17
1853......	3,159	11	21	763	5	12
1854	3,288	9	4	1,648	2	10
1855......	3,080	3	14	3,548	19	6

From the foregoing it will be observed that in 1855, the first year of the marking of goods of the lower standards without duty, the gold wares not liable to duty were more than double the amount of the former years.

The growth of the trades sending gold and silver ware to be assayed is evidenced by the fact that up to 1847, one day in each week was sufficient for the assaying and marking: in that year it was found necessary to open the office two days; in 1854, another day was added; and in 1865 the office days were extended to four days a week, and the Assay Master's duties extend into the two days when the office is closed.

The number of assays made in different years may be interesting to some of our readers:—

NUMBER OF ASSAYS MADE.

Years.	Gold.	Silver.	Private Gold and Silver.	Total.
1843	197	1,488	415	2,100
1853	320	2,157	621	3,098
1863	3,766	3,057	761	7,584
1964	4,374	3,430	750	8,554

During the first ten years of the period covered by the foregoing table, the increase, it will be seen, was about 50 per cent., during the second period of ten years it was considerably more than cent. per cent.

TABLE SHOWING THE AMOUNT OF SILVER ASSAYED FROM 1773 TO 1825.

For the year ending 30th June.	SILVER.	For the year ending 30th June.	SILVER.	For the year ending 30th June.	SILVER.	For the year ending 30th June.	SILVER.
	oz.		oz.		oz.		oz.
1774	16,983	1787	14,789	1800	29,037	1813	78,753
1775	21,197	1788	13,531	1801	37,573	1814	95,746
1776	34,673	1789	14,046	1802	42,754	1815	100,101
1777	55,789	1790	19,250	1803	52,646	1816	90,207
1778	56,933	1791	21,280	1804	42,185	1817	56,110
1779	61,220	1792	25,624	1805	58,879	1818	81,731
1780	47,415	1793	26,304	1806	76,241	1819	96,626
1781	36,375	1794	24,001	1807	77,968	1820	57,423
1782	21,806	1795	21,375	1808	86,653	1821	55,292
1783	19,288	1796	22,852	1809	83,359	1822	66,324
1784	19,381	1797	22,653	1810	98,724	1823	75,478
1785	15,282	1798	17,145	1811	105,452	1824	87,679
1786	13,257	1799	22,825	1812	84,576	...	...

TABLE SHOWING THE AMOUNT OF GOLD AND SILVER WORK ASSAYED FROM 1825 TO 1865.

For the year ending July.	Weight of Gold.	Weight of Silver.	For the year ending July.	Weight of Gold.			Weight of Silver.	For the year ending July.	Weight of Gold.			Weight of Silver.
	oz.	oz.		oz.	dwts.	gr.	oz.	-	oz.	dwts.	gr.	oz.
1825	...	111,811	1839	2,125	...	...	114,534	1853	3,604	10	21	88,279
1826	...	104,811	1840	1,997	..	..	103,869	1854	4,419	13	4	98,603
1827	...	88,800	1841	1,996	...	..	96,032	1855	5,055	...	...	84,773
1828	1,149	106,650	1842	2,227	...	...	77,977	1856	9,174	...	..	82,858
1829	888	104,811	1843	2,112	...	..	58,120	1857	11,081	...	...	84,911
1830	858	88,973	1844	2,363	...	...	69,487	1858	10,924	...	...	73,453
1831	780	97,716	1845	2,606	...	...	91,706	1859	13,279	...	...	72,285
1832	760	95,420	1846	...	..	..	103,740	1860	17,873	...	...	108,222
1833	767	86,662	1847	...	...	..	100,919	1861	16,409	...	...	78,252
1834	1,084	101,750	1848	...	...	..	82,659	1862	16,397	..	..	78,052
1835	1,118	104,761	1849	2,476	16	5	72,045	1863	19,010	...	...	85,852
1836	1,792	121,361	1850	2,963	10	6	78,397	1864	24,823	...	...	101,595
1837	2,015	109,893	1851	3,342	18	20	85,774	1865	31,960	...	...	99,951
1838	2,015	90,958	1852	3,367	12	16	77,434	...	...	...	...	...

The following table shows the amount of *Duty* collected at the Birmingham Assay Offices from 1852 to 1864 inclusive :—

YEAR.	GOLD DUTY.			SILVER DUTY.			TOTAL DUTY.		
	£	*s.*	*d.*	£	*s.*	*d.*	£	*s.*	*d.*
1852	2,197	5	0	2,816	7	7	5,013	12	7
1853	2,694	12	6	3,652	0	1	6,346	12	7
1854	2,779	15	6	3,839	16	5	6,619	11	11
1855	2,614	15	3	2,954	0	4	5,568	15	7
1856	3,360	12	8	3,451	10	8	6,812	3	4
1857	3,373	3	7	3,373	1	3	6,746	4	10
1858	3,345	9	7	3,178	12	5	6,524	2	0
1859	4,149	7	11	4,174	12	1	8,324	0	0
1860	4,593	7	6	4,764	17	10	9,358	5	4
1861	4,293	10	10	3,635	5	4	7,928	16	2
1862	4,016	5	10	4,395	2	8	8,411	8	6
1863	5,033	3	9	4,726	12	9	9,759	16	6
1864	5,653	4	3	5,490	0	6	11,143	4	9

It will be observed that the amount of silver goods assayed has not continued to increase. Taking the British Association years the comparison stands thus:—In 1839, the weight of silver goods was 114,534 ounces; in 1849, 72,045 ounces; in 1865, 99,951 ounces. In the same period the weight of gold wares had gradually increased. But a comparison, for the purpose of showing the extension of the manufacture in the town, should be made between the periods of good trade. Such comparisons will show that the manufacture of wrought silver plate has not recently increased; and this is to be accounted for by the fact that electro-plated goods have taken the place, to a great extent, of silver. And it must be borne in mind that up to 1854 watch-cases, both silver and gold, were sent in large quantities from Coventry, and since that time they have not been sent to Birmingham. This gives an additional significance to the increased weight of gold, and to a small extent only accounts for a decrease in silver. It is thought necessary by the Coventry trade to gain for the watches the reputation of being made in London, and consequently the London mark is necessary to the deception. The watch-case trade has lately been introduced into Birmingham, adding a new trade to the many which have already found the town a convenient and fruitful locality.

To enable the reader to compare the amount of work done at the Birmingham Assay Office with that of other Offices, we subjoin a Copy of a Parliamentary Return:—

For the Year ending 5th January, 1844.

Goldsmiths' Halls.	Gold 17/- per oz.	Silver 1/6 per oz.	Duty on Amount Stamped.			Amount paid for Collection.			Net Amount paid into Stamp Office.		
England.			£	*s.*	*d.*	£	*s.*	*d.*	£	*s.*	*d.*
Birmingham	1,476	27,495	3,316	16	4	82	18	4	3,216	14	6
Chester	98	656	132	4	6¼	3	6	0	128	18	6¼
Exeter	279	31,259	2,581	11	9¼	64	10	7	2,517	1	2¼
Newcastle-upon-Tyne	165	9,132	825	3	0½	20	12	7	789	10	6¼
Sheffield	...	36,836	2,762	14	6	69	1	0	2,610	2	7¼
York	28	2,080	179	18	1¼	4	9	9½	175	8	3¾
London	4,290	763,343	60,897	9	11	1,485	8	10	49,479	17	10
Scotland.											
Edinburgh...	56	25,128	1,933	0	0	48	6	4	1,884	13	8
Glasgow......	20	15,115	1,150	16	8½	28	15	3	1,122	1	5½
Total	6,412	911,044	73,779	14	11	1,807	8	8¼	61,924	8	8

For the Year ending 5th January, 1848.

Goldsmiths' Halls.	Gold 17/- per oz.	Silver 1/6 per oz.	Duty on Amount Stamped.			Amount Paid for Collection.			Net Amount paid into Stamp Office.		
England.			£	s.	d.	£	s.	d.	£	s.	d.
Birmingham	2,115	39,429	4,755	11	9	118	17	8	4,626	11	7
Chester	168	638	190	8	5½	4	15	1	185	13	4½
Exeter	266	44,451	3,560	6	2½	88	19	11	3,457	17	0½
Newcastle-upon-Tyne	193	12,523	1,103	15	6¼	27	11	10	1,060	7	11¼
Sheffield ...	...	49,246	3,693	8	4½	92	6	10	3,558	5	9½
York	32	2,274	197	12	8¼	4	18	8½	192	14	0
London	4,783	860,799	68,626	6	10	1,690	2	0	55,171	10	3
Scotland.											
Edinburgh...	65	22,219	1,721	17	2	43	0	9	1,678	16	5
Glasgow ...	7	17,689	1,332	17	8½	33	6	3	1,299	11	5½
Total	7,629	1,049,268	85,182	4	8½	2,103	19	0½	71,231	7	10½

CAST AND ELECTRO-DEPOSIT STATUARY IN BRONZE AND COPPER.

By W. C. AITKEN.

The production of bronze statuary is an art of very ancient origin. It is alluded to in Bible story, and in profane history its records are chronicled. The immense number of Alexander's statues adorning the cities which owned his sway, were characterised by an early writer as "the mob of Alexander." Corinth, alone, boasted of her three thousand statues, and exclusive of the huge Colossus, a still greater number thronged the squares and courtyards of Rhodes. In later days, bronze statuary adorned the splendour of the Byzantine Emperors, and later still, when the light of the Crescent paled before the brilliancy of the Cross, the genius of Italy claimed supremacy in this as in every other department of art. In it worked Della Robbia, Sansovino, Verrochio, Cellini, John of Bologna, Michael Angelo, and a host of other artists in whose hands it assumed endless forms of grandeur and beauty; now a gigantic statue; now a subject-fountain, cooling with its waters the noonday heat of an Italian city; now a pulpit, such as that in the great Church of St. Peter; and now a gateway to guard the entrance to the sanctuary. The doors of the Baptistery at Florence, in which the skill of Lorenzo Ghiberti has given expression alike to his piety, and the rich exuberance of his fancy, remain indeed, among the noblest monuments of ancient or modern art. Every panel is filled with a subject from Holy writ:—"The rock, the fountain, the flowing river with its pebbled bed, the great sea, the clouds of heaven, the herb of the field, the fruit-tree bearing fruit, the creeping thing, the bird, the beast, the man, and the angels, mingle their fair forms on the bronze of Ghiberti." Michael Angelo, himself, in gazing on them, is said to have whispered, "So grand, so beautiful are they, that they are worthy to be the gates of heaven." In Germany, the most celebrated artists in bronze, were the Vischers, whose fonts, tombs, and shrines, still adorn many of the churches of Germany, and particularly that of St. Sebald, at Nuremberg. The celebrated monument, also, of the Emperor Maximilian I., at Innspruck, testifies the skill of the artist casters of the period. Spain can boast of the great bronze candelabrum at Seville, the pulpits at Santiago, and the colossal "Faith" surmounting the tower of the Giralda. France can point to the tombs of two bishops at Amiens, executed in the 12th century, as tokens of her early proficiency in the art. Bavaria, within the last thirty years, has produced many noble bronze statues, as witness the one of Hermann, 42 feet high; and the majestic "Bavaria" that overlooks Munich from the Theresien Weise, modelled by Schwanthaler, but cast by Stiglmaier, 50 feet high, and cast in seven pieces.

Bronze statues, cast by Englishmen, such as William Torrel, at an earlier period, and William Austin, at a later, were also not uncommon in England as monumental memorials. Torregiano executed the monument of Henry VII.; Rovezzano, those of Henry VIII., and his wife, Jane Seymour, in Westminster Abbey. For our first public statues, we are indebted to the fine taste of Charles I., whose bronze effigy, in Charing Cross, was modelled and cast by Le Sueur, of the School of John of Bologna. That of James II., in Whitehall Gardens, is the work of Grinling Gibbons, the celebrated wood-carver. With the Georgian era came in an increased demand for bronze statuary, and the bigwigs and Roman toga reigned for a period. For many years previous to 1823, Westmacott had been the only caster of bronze statuary in England; one example of his being the Nelson, in the Bull-ring, which for at least fifty years was the only statue of which Birmingham could boast. In that year, the first life-sized bronzed statue ever produced out of the metropolis was cast in Birmingham, by Sir Edward Thomason, at the Church-street Works. The worthy knight, following the advice of the great Florentine, Benvenuto Cellini, who declared it to be "The duty of all men, in whatever state or condition of life they are placed, who have performed praiseworthy actions, or distinguished themselves by gallant exploits, to be their own biographers," thought fit, in his 66th year, to publish certain details of his autobiography, under the title, "Memoirs of Half-a-Century." In this work, the history of the casting of the first statue in Birmingham is thus given:—In 1823, Thomason caused to be made a model, 6 feet in height, of

George IV., "the attitude of which was the King in his robes of state, with the sceptre in his right hand, and holding back the folds of his robe with his left." Up to this time, Westmacott was the only caster of bronze statuary, of a large size, in the kingdom, and the process by which he cast was kept secret.

> "The moulds of my figure were made of a peculiar mixture of fine sand and plaster of Paris. They were dried by many small stoves all round the inside of the casting room. The core was suspended in a beautiful manner by innumerable small wires called pins, so that the copper or metal should flow round the core and melt them when the metal was poured in. I had built a cast-house, and after a minute examination of the moulds, finding them perfectly dry, the furnace of the tall chimney was charged with a quantity of the purest refined copper, with a fraction of lead and zinc. Suddenly I recollected reading of the alarming state in which Benvenuto Cellini found himself on suspecting at the moment of the casting of his Perseus, at Florence, that he had not charged the furnace with sufficient metal (the sure forerunner of a failure), that he was that morning laid up with the gout,* and that in the height of irritation he sent round to his neighbours to buy, borrow, or beg all their copper kettles, stewpans, saucepans, &c. I was determined that mine should not fail for want of this precaution; therefore I had two tons and a half put into the furnace. Large bellows were suspended and worked by relays of men, without ceasing, during the time of fluxion, which I found took from eleven o'clock on the Thursday till seven o'clock on the Saturday morning. I then gave directions that the trial should be made and the furnace tapped. Exactly at two o'clock on Saturday, October 2, 1823, this decision of mine being made known, many persons of great respectability requested to be present. I endeavoured to persuade them from it, having heard of many instances that whilst the hydrogen gas was formed by the hot metal coming in contact with the damp sand (the sand having been carelessly dried), an explosion did in one case absolutely blow up part of the building. No remonstrance would do, and the cast-house was completely filled with respectable persons of both sexes. The metal, however, ran as pure as water, without accident or blemish. It took about four days to cool, and was found quite perfect. My modellers had been alternately modelling the statue of the king and the four Venetian horses [copies of those which now stand above the façade of St. Mark's Church, at Venice, the work of Lysippus, a celebrated Greek sculptor, who lived 325 years B.C.], of their proper height, each being 5ft. 4in. Having understood that the attempt had never been made before, I decided to have them done after an idea of my own. I therefore obtained a small model of them. I made up my mind that they should be finished and mounted upon the pediment of my manufactory on the same day that the statue of his Majesty should be cast. This was effected, to the astonishment of my townsmen."—Vol. I., 245—248.

With this feat, probably, would have terminated the history of bronze casting in Birmingham, but for the spirit and enterprise of the Messrs. Elkington, who subsequently added this to their other processes connected with fine art manufacture.

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* The knight gives a remarkably free reading of Cellini's doings. It was not the "gout" with which he was afflicted, but an intermitting fever; nor is there any evidence of a deficiency of metal. Owing to a workman's negligence the metal had been allowed to cool, and the "sixty pounds of pewter and all my pewter dishes, amounting to about 200," were put in to render it more fluid. He did not, however, buy, borrow, or beg his neighbours' copper kettles, &c. The deficiency, amounting to almost half of one of the feet of the statue had been anticipated by Cellini, who pointed out to Duke Cosmo de Medici that such a result was probable.

The processes involved in the production of bronze statuary are numerous and interesting. In the *cire-perdue*, or wax process, the core is built up on a structure of iron bars, which forms the skeleton of the statue, the bars following the curves of the extremities of the figure, human or equestrian, the arms of the man, the arched neck, the legs and tail of the horse, &c. This skeleton stands on a platform with provision for introducing fire under it, so as to allow the wax used in the process to be withdrawn. It is then built up with a mixture of clay, pounded brick or burnt clay, horse-dung and hair, capable of being easily worked when moist and very solid when dry, so as to present the general contour of the subject, but less than the proposed statue by just the thickness of the metal to be employed. Over all this is laid wax to the same thickness, on which the sculptor works and expresses all the details. When the work is satisfactory from every point, ascending rods of wax, representing the channels by which the air is to find exit on the metal entering the mould, are placed wherever required. Viewed in this state, the model and its accompaniments strongly suggest the venous and arterial system of the human body as shown in anatomical works, with the difference that the wax-rods are external to the body of the model, which is visible through their intervening meshwork. The whole model and rods are then painted over with fine loam in a liquid state. This speedily dries, and another coat is added, the process being repeated until the crust is sufficiently strong to sustain a superincumbent mass of thick loam plastered on, the mould thus formed having a rough resemblance in general form to the statue to be cast; after which it is bound round with hoops and bars of iron. The platform before-mentioned, on which the model is built up, is either at the bottom of a pit, or stands over a pit into which the mould can be lowered before casting. This pit, when the mould has arrived at this stage, is filled up with sand and bricks to the level of the surrounding ground, so as completely to envelope the mould, the wax-rods projecting to the surface. A fire is then lighted under the platform, and the wax forming the outer coating of the core, and exactly representing the metal to be cast, melted out. The mould is then gradually heated up to nearly a red heat, and when completely dry is in a condition to receive the molten metal from a reverberatory furnace standing on the surface of the ground in close proximity to the mould. Jets are made for the introduction of the metal, and the apertures left by the melting of the wax-rods afford a ready means of exit for the air. The plug of the furnace is withdrawn, the metal flowing out enters the mould, fills it, and the statue is cast. If the air in the mould is not completely expelled, it becomes condensed, and presents an obstruction to the metal, a defective portion in the statue being the result, as in the foot of Cellini's Perseus in the grand square at Florence.

The *cire-perdue* process, assuming the cast to be taken from an original model, is a hazardous operation, since, if the casting is defective, the entire work of the artist is lost, as was the case with the first competitive panel for the Baptistery gates, at Florence, cast by Ghiberti, which he consequently had to re-model.

By this process was cast the statue of Louis XIII., in 1699, the whole being cast in one piece. It is now usual to cast large works in several pieces. Thus, for instance, in an equestrian statue, the body of the horse, its neck and head, its legs and tail, and the body of the rider, would all be separate castings, afterwards united with pins, or "burned" together by causing a stream of metal to flow over the junction of the pieces in juxtaposition until they are fused into one. There are methods, however, of employing the *cire-perdue* process without losing the artist's work in case of accident. A plaster cast, or series of piece-moulds, is sometimes taken from the model, and this cast filled with the necessary thickness of wax arranged round another core. Another method is to build up the piece-moulds taken from the original model round the core, pour in the wax, remove the mould, add the necessary air-channel pipes, and proceed as before.

The *cire-perdue* process was the one employed by the Chinese and Japanese, for the production of many of those peculiar and complicated castings which figured so conspicuously in the International Exhibitions of 1851 and 1862.

Another method, however, is generally practised for moulding figures in bronze. A model is made in plaster, and a piece mould of Caen sand about 1½ inch or 2 inches thick made round it, the sizes of the pieces being determined by the shape and character of the portions they copy. These pieces are backed with plaster of Paris to about a foot in thickness, with indentations cut in their horizontal thickness into which the succeeding portion of the mould fits. The mould is then taken to pieces, dried, and rebuilt in the casting pit. It is then filled with core composition in a liquid state, and when this is sufficiently hardened again taken to pieces. The core thus obtained is thoroughly dried, and reduced in size by scraping away as much of the material as would represent the thickness of the metal to be cast. This done, the mould is again built up over the core, and the pit filled, &c., as in the former process. The statue is completed, after its removal from the mould, by cutting off the "jets," removing roughnesses where they occur, and giving greater sharpness to the details when necessary, by means of large chasing tools and riffles. The ancient Greeks had another method of casting, which depended on the shrinkage of the material of which the core was made, this shrinkage of the core from the mould forming the space into which the metal was poured.

The composition of bronze varies very slightly in the older examples. It is occasionally formed by adding a small proportion of lead to the copper and tin.

Since the introduction of the art of artistic bronze casting into Birmingham, the following statues have been cast by Messrs. Elkington, at the Newhall-street Works. 1. Sir Robert Peel, 7ft. high, modelled by Mr. P. Hollins, now standing at the top of New-street. 2. General Ferè, 7ft. 6in. high, sent to South America. 3. The "Guards' Memorial," consisting of three guardsmen, 9ft., and a figure of Victory, 10ft. 6in. high, modelled by John Bell, now standing in Pall Mall, London. 4. Three equestrian statues of the late Prince Consort, modelled by Thornycroft, 13 feet high, distributed to Liverpool, Halifax, and Wolverhampton. 5. Last, but not least, the noble and chivalrous colossal equestrian statue of Lord Hardinge, modelled by Foley. Around it, in the square of Calcutta, where it stands, the Arab horse-dealers gather at sundown, and comparing the steed with their own desert-born barbs, pronounce it no work of human hands, but those of the wonder-working genii, while the natives gazing up in reverence, whisper of the doings of the "Great Sahib."

It is matter of regret that with the exception of a portion of the Hardinge group, no record of the weights of these statues can be furnished. The body of the horse in the Hardinge statue weighed 4¼ tons, a considerable portion of the metal being furnished by guns captured in the Affghan war by him whose memory they now serve to perpetuate.

It will be at once understood that the production of a bronze statue of colossal or even life-size by any of these processes is a work of great difficulty and no little risk. Even with every precaution, an immense force is exercised on the walls of the furnace by the molten metal, by which they may be burst; the mould may fail just as the metal enters it; compressed air may rend the mould and allow the metal to escape; the metal itself in running may, by some unforeseen event, occasion failure in the casting, and thus the artist's labour of months or even years be sacrificed in a moment.

ELECTRO-DEPOSIT STATUARY.

But science, in her bounty, has provided other means of reproducing the sculptor's labours on his clay or waxen model, in enduring metal, with a certainty of success and impossibility of failure. The agent by which this reproduction is effected is untiring in its operation, strong now and for ever, as on creation's morn, pervading all nature, the source of light and heat, heard in the roll of the thunder, and made visible in the lightning's flash. Captured by science and chained to her car, it has become docile, obedient, and willing under the kindly care of Philosophy. Though first received with suspicion at the gates of Industry, once fairly within her portals, with a tub for a kitchen, and an earthenware tube for a parlour, fed on cakes of zinc, buttered with quicksilver, and with acid to drink, it first showed a specimen of its working powers in the copy of a little coin, but so thin, so very thin! With further encouragement it copied a basso relievo,—a little thicker;—then it produced a statuette. "Give me more elbow-room," it cried; "Increase the number of my chambers! Give me more cakes, more drink! Lengthen my arms of copper-wire! Make my workshop bigger, I care not how far distant. I will work from eve to morn, from morn to dewy eve; I want no day of rest! Give me what I ask, and leave me alone to work!" And its kindly masters,*—now, alas! no more,—gave it all it asked and left it. Weeks and weeks afterwards, in the plaster mould left in its workshop-bath of coppery blue water, was found the metal statue of a man, not a mere film in thickness, but stout and strong. Many a time and oft, since then, has it done likewise, creating everlasting images that shall present to the eyes of coming generations the features of men mighty in battle and wise in council, noble benefactors, lordly poets, deep historians, students of science, careworn and sorely buffetted in life, who have enriched the world by inventions that have cheapened production, diminished labour, and ministered to the material comforts of all ranks and conditions of men.

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* The late Henry and G. R. Elkington, Esqs.

What is this power by which the statue is built up, particle by particle, as the bee builds up her cell? It is born of the subtle fluid which pervades the universe. It is recognised by Science as Electricity, Magnetism, Galvanism. Its name in Industry is Electro-Metallurgy.

The process is simply that of depositing metal, restored to its metallic form from a solution, on a surface exposed to the action of a galvanic battery—the apparatus being enlarged, the battery power increased, the solution-vats widened and deepened according to the requirements of the moulds, and the quantity of the solution in which after being prepared they are immersed. Troughs are now provided as much as 15ft. in length, 8ft. in width, and 9ft. in depth, capable of containing 6,680 gallons. The strength of the solution of sulphate of copper is maintained by immense sheets of copper suspended in the vat. The moulds are in plaster, and taken from the original model in pieces of such a shape and size as to be easily removed, and readily put together again. After being varnished, to hinder absorption of the solution, the interior of the mould is coated with black lead, which attracts the copper thrown down from the solution when decomposed by the electric current, and which, grain by grain, builds up the statue. It is an error to suppose that statues thus produced are necessarily thin or irregular in thickness of substance. I have seen examples of deposited copper ¾in. in thickness, and few of the statues I have examined were less than ⅜in. If solidity of substance and purity of metal can ensure durability, then assuredly the copper statuary produced by this process may be expected to be everlasting. That pure copper resists the action of sea-water better than any other metal has been proved by its employment in sheathing for ships. Its indestructibility by exposure to the atmosphere is evidenced by the preservation of the statue of Buddha, belonging apparently to the earlist ages of the Buddhist faith, and consequently nearly 2,500 years old, discovered at Sooltangunge, on the Ganges, and lately presented to the Birmingham Art Gallery, by Mr. S. Thornton. This statue, however, is cast in unrefined copper, as will be seen by the following analysis furnished by Daniel Forbes, Esq., F.R.S.:—

Copper	91·502
Iron	7·591
Silver	0·021
Gold	0·005
Nickel	.........traces
Manganese	.........traces
Arsenic	0·079
Sulphur	0·500
Insoluble slab	0·292
Total	100,000

If copper thus impure, and with iron in its composition, will last for twenty-five centuries, there seems no practical limit to the probable durability of metal at once denser and purer than any cast copper can possibly be. The idol itself is cast, and filled with sand, which, in all probability, formed its core, the thickness of the metal being by no means so uniform as that of a deposited statue.

By electro-metallurgy, as has been said, all risk arising from an immense accumulation of molten metal is avoided. The action of the electrical current is certain in its operation, and with batteries of sufficient power, and vats of sufficient dimensions, there is no limit to the size of the object that can be produced. So far as the active power itself is concerned, it could, with the same ease, take an impression of a threepenny piece or build up grain by grain a colossus like that which, with a stretch of fifty feet from rock to rock, bestrode the harbour mouth of Rhodes—the Titan of statues, one of whose thumbs no ordinary mortal could embrace, whose little finger exceeded the dimensions of most life-sized statues, and under whose mighty stride could pass a vessel in full sail, haply guided by the lamp upheld in the outstretched hand, which the mariner, at night, could see from the Egyptian shore, and bearing homeward to their citadelled city a company of Knights of St. John from battle with the Paynim Infidel onHoly Land.*

A prejudice against statues produced by electro-metallurgy was at first created by some examples of very limited thickness of metal having got abroad, from an examination of which it was concluded that the process could not accomplish work of a more substantial character. That this prejudice has now almost entirely disappeared will be evident from the following enumeration of works produced by Messrs. Elkington within the last five years :—

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* The Colossus was the work of Chares, of Lindus. It took 12 years to produce, and cost a sum equivalent to about £70,000. It was thrown down by an earthquake, and the Rhodians, forbidden by an oracle, refused the proffered aid of Greek and Egyptian artists to restore and re-erect it. In the year 655, the Saracens being then in possession of the island, the metal was sold by an officer of the Caliph Othman to a Jewish merchant, who, we are told, loaded 900 camels with the fragments. [If the Colossus bestrode the harbour, and was thrown down by an earthquake, it must have fallen into the sea.—EDITOR.].

SUBJECT.	HEIGHT.		ARTIST.	WHERE ERECTED
	ft.	ins.		
Samuel Crompton, the persecuted inventor of the Spinning Jenny. A seated figure	7	6	W. Calder Marshall	Bolton.
Oliver Goldsmith	9	6	Foley	Dublin.
Exhibition Memorial, comprising,				
1. Her Majesty as "Peace"	10	6	Durham	Hyde Park, London.
2. The Prince Consort	10	6		
3. Europe	6	6		
4. Asia	...			
5. Africa	...			
6 America	...			
The Prince Consort	10	6	Durham	Guernsey.
A Naiad	6	0	Alex. Munro	Boston.
Lord Hill	6	6	W. Theed	Wellington College.
Lord Howe	...			
General Murray	...			
Lord Hopetoun	7	0		
Lord Combermere	6	6		
The Prince Consort	6	9	Durham	
Sir W. Stevenson	8	6	De Epegry	Mauritius.
The Prince Consort	6	9	Theed	(For Duchess of Sutherland)
— Feilden, M.P.	8	6	Foley	Oldham.
Malcolm Canmore, King of Scotland	6	6	Theed	Balmoral.
General Seaton	8	0	G. G. Adams	
The Earl of Eglinton, L.-L. of Ireland	13	6	McDowell	Dublin.

The statue last named weighed two tons, and was three-eighths of an inch in thickness throughout.

It is now customary to cast bronze statues in several pieces, and the same plan is observed in those produced by electro-metallurgy; the belts, or other ornamental projections in clothing or armour, offering the means of effecting the junctions without rendering them obtrusive. After being taken from the mould, the several parts are trimmed up and fitted together, and the whole statue is coated with a liquid bronze to give uniformity of colour. An oxide once formed on the surface decay is arrested, the density of the metal preventing its penetrating beyond a mere line in thickness.

On the whole, judging from the progress made within the last five years, it seems highly probable that, in the production of bronze statuary, the process of casting will ere long be entirely superseded by the simpler, safer, and more certain operations of electro-metallurgy.

THE ART OF STAINED GLASS IN BIRMINGHAM.

By JOHN HARDMAN POWELL.

The old English spirit of architectural and decorative art, after a trance of centuries, has now happily revived, and is rapidly recalling its old expression to the face of the country. This great reaction is felt to the furthest corner of our island; and excepting, perhaps, that of the fifteenth century, is without a parallel in its Art-history. Of this movement, the revival of stained glass has become an important feature, and the demand for coloured windows seems, from its urgency, as if actuated by a desire to expiate the blind fury which tore down the ancient glass, and the ignorant neglect which left it to drop from its lead-work.

Birmingham and its suburban churches—St. Martin's, old St. John's (Deritend), the Chapels of St. Catherine and the Friars Minor, Edgbaston, Harborne, and Aston, all, without doubt, were once partially, if not entirely, glazed in the ancient manner; but not a fragment of the glass remains to show us what it was. All record even of it has perished, except a meagre mention by our historian of three coats of arms of the Lords Dudley, Tamworth, and Birmingham in the chancel windows of St. Martin's, and of some old armorial glass of the Dudley family, and a figure of Sir Walter Arden, in St. John's, Deritend.

It does not seem to be known whether glass-painting had been practised in Birmingham before 1784, but it is nearly certain that, if so, the art had been dead for a long time previously. In that year Francis Eginton first began to paint glass at Soho, where he is said "to have brought his art to astonishing perfection." He seems to have produced a great number of works, among which are cited, windows for St. George's Chapel, Windsor, containing the arms of the Knights of the Garter; for Salisbury and Lichfield Cathedrals; St. Asaph's and Magdalen College, Oxford. In the last he restored from an engraving, by Sadeler, a "Last Judgment," by Christofer Swartz, which had been injured by a storm in 1703, besides painting eight other windows of benefactors in the ante-chapel. Windows of his workmanship are also to be found in Merton College Chapel, the palaces of the Bishops of Derry and Armagh; Wanstead Church, Essex; and St. Martin's Outchurch, London. He also painted glass for Hampton Court, Wardour and Arundel Castles; and in August, 1794, Beckford gave him a commission for windows, amounting in value to £12,000, for Fonthill. Orders, moreover, are said to have poured in from foreign Courts; and some of his finest windows are reported to be at Amsterdam.

In these works no knowledge whatever is shown of the mediæval principles of glass painting, or rather a direct antagonism is displayed to all the canons of ancient art. The designs, stretching over the whole light, without borderings or geometric or architectural forms, were divided into a number of squares by an iron frame, which gives them the appearance of being seen through a portcullis. They were made out entirely by enamel colour—brown shade and yellow stain on a white base, with little or no outline and few leads. The drawing and tinting of the draperies and complexions is generally soft, dreamy, and pulpy; the composition, colour, and effect, being often marked by the feeble elegance so common in pictures of the style in which Sir Joshua was master. These works, in fact, are so many pictorial transparencies. As windows, they set at defiance all the rules of art and every principle of construction. Still, in despite of their defects, we are constrained to feel grateful to the man who was the pioneer in our town to break out of the dreary blank of white light in which we were lost—who did something while others did nothing—who made earnest efforts, believing in his craft—and who really produced large and imposing works under tremendous difficulties.

We have a few specimens of his work near us. One is the east window of the south aisle in the old church at Aston, put up in memory of Letitia Dearden, about 1792, by Catherine and Edward Johnstone. For subject there is one peach-cheeked damsel being assisted to rise out of a very brown cracked tomb by two others in wings—all done in enamel. His most important work, however, in this neighbourhood, is the east window of St. Paul's, one of the "lions of the town," of which our historian magniloquently says—"This window was made by that celebrated artist, Francis Eginton, in 1791, at a cost of

400 guineas." It presents to the spectator a sea of bistre, with a few finger points of light and streaks of colour. It is not till the eye has become accustomed to the sombre tone, that masses of huge brown limbs are discoverable—then a horse's head—then a herculean St. Paul daringly displayed across the centre light. Above, the figure of our blessed Lord is seen falling through a bright rent in some very black clouds. On the dexter side is a group which may be intended to represent the Christian Church suffering under Saul's persecution—brown flesh in quantities, with a few pieces of rich colour. On the sinister side is St. Paul in an agony, supported by an attendant, and receiving his sight from a very sun-burnt Ananias. Two-thirds of this window are positively opaque by any ordinary light; and if the entire church were filled with glass of the same character, the congregation would have to grope about for their pews at mid-day. Nevertheless, there is a far superior tone about this window to that of most glass of the same period. It is a bold and great effort. Eginton could have been no mean or timid artist, and must have been well conversant with the works of the Italian painters of the 17th century.

Francis Eginton died on Lady-day, 1805. William Raphael Eginton, probably son of Francis, is marked in the Birmingham Directory, of 1818, as glass-painter and stainer to her late Royal Highness, the Princess Charlotte of Wales, and the Duke of Sussex. In the same work is mentioned H. H. Peacock, ornamental glass-painter, New-street. Of their works, we know simply nothing.

F. and C. Pemberton come next in historical order. They boldly proclaimed their adherence to the principle, that glass-painting may legitimately attempt all the effects of the finest paintings and frescoes. In 1849, they spoke of Eginton as "the great reviver of modern glass-painting," and were, consequently, quite consistent in upholding the superiority of smooth glass as a rule to the older and more uneven material. It is, therefore, no matter of surprise to find in their works the same wants of definite rules as in Eginton's, and the same absence of the jewel-like beauty so conspicuous in the ancient examples. Their works have been chiefly of a domestic character.

Messrs. Chance Brothers and Co., whose large Glass Works are justly celebrated, have for many years carried on a branch of painting on glass. For the success of this department, they at first engaged the services of M. Bontemps, who communicated some interesting results to the chemical section of the Meeting of the British Association in 1849. After M. Bontemps, Mr. Jones was head of the department till 1857, when he was succeeded by Mr. Sebastian Evans, who had previously been associated with the Mr. F. W. Oliphant, presently to be mentioned. During the time that the talent of this artist was employed on their works, a marked change was observable. The old rough make of glass was brought more into use, and for the Exhibition of 1862, a very important work was produced from Mr. Evans's drawings, well-known as the "Robin Hood Window." Although its merits were under the disadvantages of being placed in a position and light totally unsuited to them, there was ample evidence of the great advance made by this firm since the Birmingham Exhibition of 1849, where their best work was the East window of the Cemetery Church, Hockley. Besides the Robin Hood Window, some smaller lights of foliage were exhibited in 1862, which displayed still more clearly an observance of the old principles. The material, made by themselves, was brilliant, and the arrangement geometric and mosaic in treatment.

Robert Henderson was a Birmingham painter on glass for many years. He started in Temple Row about 1820, and removed, later, into New-street. His works are in enamel, chiefly of the domestic character of that unhappy time; sandy-red borders, strong orange vine-work, in high relief, with black shadows. Some, however, are of a better class; such as the enamel windows at Castle Bromwich Hall, Mr. Russell's, at Handsworth, and one of a heraldic character, at Alton Towers, painted for Earl John, of Shrewsbury. He painted a few ecclesiastical works—a "Carriage of the Cross" for Bilston Catholic Church, and some emblems in Trinity Chapel, Birmingham. He died in 1848.

In 1837, Mr. John Hardman, then of Paradise-street, in this town, became acquainted with Augustus Welby Pugin, who had just aroused the attention of Englishmen to the degraded state of their architecture and art by his scathing denunciation of the Pagan Renaissance of the 16th century, and by his unmerciful exposure and castigation of shams in construction. They soon formed an almost brotherly friendship, which lasted undisturbed during fifteen years of daily correspondence and frequent personal converse, until the fiery genius of Pugin was so early consumed in its own fierce brilliancy. This friendship resulted in Mr. Hardman's undertaking to start metal and glass works, on strict mediæval principles, from the designs of Mr. Pugin. In the former, Mr. Hardman was master of all the processes: in the latter, he required the assistance of some one skilled in the practical mixture of the yellow and brown stains, and in burning in the kilns. The two sons of Robert Henderson possessed these requisite qualifications, and the elder was, besides, a fair painter on glass. An engagement was made with them and with their chief painter, Mr. Hinckley, who had been with them twenty-four years. A muffle was built, and with two or three boys the work was started. Before this time, Mr. Pugin had had many successful windows made from his drawings by Mr. Wailes, of Newcastle, and Mr. Warrington, of London, some of which are in St. Chad's Cathedral in this town; but he was wishful to have his glass executed more immediately under his own care, and the direction of one whose views for the progress of mediæval art were entirely in accordance with his own, and whose energy and earnestness promised active co-operation in the work. Mr. Pugin, having undertaken to find designs and drawings, built a cartoon-room attached to his house, St. Augustine's, at Ramsgate, and there, with his son Edward, then a boy of eleven, and the fortunate writer of this report, who had just become his pupil, he made the cartoons for his first windows at St. Cuthbert's College, Ushaw, frequently producing as many drawings before breakfast as would suffice an artist of ordinary energy for a whole day's work. Orders came in fast, and it was necessary to procure assistance. Mr. Francis W. Oliphant, an artist well skilled in drawing the human figure, and a firm believer in the true principles of his art, whose early death is deeply to be deplored, was accordingly employed, and frequently went down to Ramsgate from London. Still the orders multiplied, and youths were sent down from Birmingham to be taught in the right way. In the course of time a band of draughtsmen was thus formed, sufficiently skilled, after the sad death of their great master, to carry on, under Mr. Hardman's guidance, the large works in stained glass which had been started on so small a scale fifteen years before.

Mr. Hardman found it necessary still to extend his works, and consequently removed to more convenient premises in Newhall Hill. During the twenty-three years that have elapsed, the processes have been gradually improved, and the number of works executed has been very considerable. With very few exceptions, and those for special reasons, no works have been repeated; but each one has been designed and carried out in the style of the stonework it was intended to fill, and with a careful eye to the circumstances of its situation.

For the last few years as many as from 80 to 100 hands have been employed, and in nearly every instance Birmingham youths have been taken as apprentices. One was a bricklayer's lad, another cleaned an engine, another made his first outlines in chalk—caricatures of his friends, of course, on the soles of the shoes he had to brush—a circumstance which first drew Mr. Hardman's attention to his talent. On the whole, there is ample proof that even in towns so intimate with coal and iron as Birmingham, so apparently given up to a worship of material, plenty of artistic talent is to be found, which only requires, as all arts do—the highest most of all—fostering and cultivating, in order to produce good fruit.

A sketch of the progress of stained glass in this town would be incomplete without mention of the works of Messrs. Lloyd and Summerfield, at Birmingham Heath, who for at least thirty years have made coloured glass for this purpose with great success. They made the first glass from old specimens painted by Mr. Hardman, and though Messrs. Powell, of Whitefriars, and Hartley, of Sunderland, have deservedly earned so much praise for their imitations of the make and tones of the old glass, still there are many colours made by our townsmen that have not been surpassed, if equalled.

Altogether, the retrospect of the three-and-twenty years is decidedly encouraging. The true principles of the old art have been triumphantly re-established on the ruins of the picture-making process; the rough glass has triumphed over the smooth—pot-metal over enamel—mosaic treatment over shadowed relief—artistic conventionalism over mechanical imitation of nature—symbolisation over material representation. We may be well pardoned for being jubilant over so important a victory, won, not by superiority of artistic talent, but by the mere fact that an observance of the true and constructive principle of the art has been once more recognised as the one condition of excellence.

BIRMINGHAM FLINT-GLASS MANUFACTURE.

Among the many causes which determine the settlement or the extermination of particular trades in particular localities, religious persecution is by no means the least important. The ribbon trade at Coventry is deeply indebted to the revocation of the Edict of Nantes in 1689, and the glass manufacturers of the Birmingham district owe their establishment to a colony of Hungarians and Lorrainese, driven from their country during the religious wars of the 16th century—in all probability while Edward VI. was on the throne of England, and the French Henry II. was fighting the battles of Paul IV. against his most Catholic son, Philip II. of Spain. At all events, as early as 1557, it appears that Thomas and Balthazar Hennezel, together with other relatives, of the names of Tyttery and Tyzak, had commenced the manufacture of glass at Stourbridge,[*] while others of the same family had settled themselves at Newcastle-upon-Tyne; the inducement in both cases probably being the abundant supply of fire-clay, admirably adapted for glass pots, and of mineral fuel, at that time beginning to be regularly employed in manufacture. At both places they appear to have established and maintained for many years a monopoly of the trade, and their descendants, the Ensells, of Stourbridge, enjoyed a high reputation as flint-glass manufacturers until a recent period; one of them, Mr. George Ensell, of Steelhouse-lane, in this town, being still connected with the business. In Birmingham itself, the flint-glass manufacture has not been established more than about eighty or ninety years.* As with all other manufactures in which machinery can only play a very secondary part, and which is principally dependent on individual aptitude, skill, and experience, its progress has been very slow, and is perceptible rather in increased facilities of production and general average improvement in the goods manufactured than in the superiority of individual examples. In fact, so far as skill in manipulation and beauty of material are concerned, the most elaborate specimens of modern cut-glass are no better than those of thirty years ago, although displaying a marked advance in elegance of form and appropriateness of decoration.

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[*] In Nash's "History of Worcestershire" we find the following remarks:—"Broad glass has been made here (Stourbridge, 1799) for several generations, ever since it was first brought into England from Lorrain, and crystal glass has long been made here, but the art of cutting and engraving it was not long since brought from Germany to London, and from London hither."—Editor.

Although, however, the general system of manufacture has remained for many years practically unchanged, many minor modifications have been introduced of considerable importance, and the final abolition of the duty on glass in 1845 has, by stimulating production, materially affected the conditions under which the manufacture is conducted.

As regards material, if the colour and brilliancy of the best old glass are seldom surpassed by modern manufacturers, much has been done towards ensuring the certainty of a satisfactory quality in the manufactured article by a stricter attention to the purity of its constituent elements. The flints formerly employed, which gave their name to the glass, were long ago almost entirely superseded by sand, from Lynn, in Norfolk; Alum Bay, in the Isle of Wight; the neighbourhood of Aylesbury, Leighton Buzzard, and elsewhere. The French sand from Fontainebleau was, however, found to be, on the whole, the best adapted to the purpose, and it is now almost exclusively employed in the manufacture. Its price at the present time, delivered in Birmingham, *viâ* Gloucester, is 24/6 per ton. The carbonates and nitrates of potash and soda, as well as the litharge or red lead employed are also now prepared with greater care; and the manufacturer, if he is still somewhat in the dark as to the precise proportions in which his materials should be mixed to produce the best result, can at least rely on their purity with greater confidence than formerly. It is curious, in the present state of chemical science with regard to atomic compounds, that no two manufacturers should employ exactly the same mixtures; and scarcely less curious, in these days of rapid intercommunication, how widely the general character of the flint-glass manufactured varies in different localities. Speaking generally, the flint-glass of the Birmingham district, the specific gravity of which averages not less than 3·20, contains a larger amount of lead than that manufactured elsewhere. At Newcastle-on-Tyne, for instance, the proportion in most cases is considerably less; and from the Bohemian flint-glass lead is almost entirely absent. This metal, it would seem, was first regularly employed in the manufacture at the Savoy Works, under the auspices of the Duke of Buckingham, in the time of Charles I. Down to that time flint-glass had been fused in open pots heated by wood fires; but wood had become too expensive to use for the purpose, and mineral fuel was substituted. The smoke of the coal, however, spoilt the quality of the glass exposed to it in the open pots, and closed pots were substituted. With the closed pots came a greater difficulty of fusing the glass, and the consequent necessity of using a powerful flux. Lead was employed, and not only acted as a flux, but imparted to the glass a lustre and brilliancy unknown before, by heightening its power of refracting light. From that time downwards this metal has formed one of the principal, as it is one of the most expensive, constituents of flint-glass in this country. In fact, the practical question thenceforth became whether it was more profitable to manufacture comparatively dear goods with a maximum of brilliancy, or comparatively cheap goods with a minimum of lead. As a general rule the Stourbridge and Birmingham manufacturers have acted on the principle of commanding a high price by the superior quality of their glass. Almost all the best glass in the English market is manufactured in this district, although a considerable portion of it, afterwards cut or engraved in London, passes for London-made. At Newcastle, on the other hand, the manufacturers generally have acted on the principle of commanding a market by the cheapness of their goods. Even in Birmingham the Newcastle glass finds an extensive sale. In London they have held a middle course. The London glass is hardly so brilliant as that of Stourbridge, but it contains more lead than that of Newcastle.

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* No glass seems to have been made in Birmingham before the year 1785, when Isaac Hawker, who was established as a "glass cutter" in 1777, erected a small glass-house in a court behind his shop, 14, Edgbaston-street. His son extended the trade, and built the works at Birmingham Heath, now carried on by Dr. Lloyd (Lloyd and Summerfield); and from whom some facts in the above paper have been obtained. In 1798, Mr. Johnston and Mr. Shakespeare erected a glass-house in Walmer-lane, and the son of Mr. Shakespeare built the works in the Lodge-road, known as the Vesta Works, and carried on by Mrs. Walsh Walsh.—EDITOR.

The history of the "pressed-glass" trade* affords a curious illustration of the result of adopting their different courses. The process of "pressing" flint glass, or shaping it into form by means of a metal mould and plunger, which appears to be an American invention, was introduced into this country by Messrs. Richardson about 1832. Before long it was adopted at the works of Mr. Rice Harris, then one of the principal Birmingham flint-glass manufacturers, and for many years was carried on with remarkable success in the manufacture of tumblers, dishes, &c., in imitation of cut-glass. The invention was novel. The material was of the same brilliant quality as cut glass; the appearance, to an ordinary eye, was the same, and the price was greatly lower. A few years later the process found its way to Newcastle. The Newcastle glass was not quite so brilliant, but it could be produced cheaper, mainly because it contained less lead. In the case of real cut-glass, wherever the work is elaborate, the cost of even the best material bears only a moderate ratio to the cost of ornamentation. In the case of pressed-glass, on the contrary, the cost of ornamentation bears but a comparatively small ratio to the cost of material. In the former labour, in the latter material, is the most important item in the cost of production. Those who could afford real cut-glass never greatly favoured the imitation, and those who purchased pressed-glass on account of its cheapness were not scrupulously critical as to nice distinctions of colour and brilliancy. If pressed-glass was to be purchased at all, the Newcastle glass was nearly as good in quality, quite as useful, and perceptibly cheaper. The consequence was inevitable. The Newcastle pressed-glass business has steadily waxed, while the Birmingham has waned. The manufacture still continues an important one in the town, but there is no prospect of its again being one in which Birmingham will hold more than a secondary place. Other circumstances no doubt have influenced this result, but the main cause at work has been and is the comparative cheapness of the material when lead is more sparingly employed. Nor is the partial loss of this particular department of the manufacture to be regretted, either from an artistic or a manufacturing point of view. Fire-polish, at best, is an unsatisfactory substitute for the clear, even polish of the wheel, and the direct finish of the workman's hand is always preferable to the mechanical tameness and sameness of the moulded copy of a mould. As a question of trade, our great manufacturers, in the long run, will have no cause to complain of being forced into dealing in higher-classed goods, in which this district need fear no competition but its own.

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* "Glass-pinchers" are registered as a separate trade as early as 1777, and the names and addresses of eleven appear under that classification in the Directory of 1780, but only eight in that of 1784.—EDITOR.

Before leaving this part of the subject it should be observed that flint-glass for optical purposes, in which lead is employed in far greater proportions than in ordinary flint-glass, is extensively manufactured at Messrs. Chance Brothers and Co.'s Works at Spon Lane. Probably no feat in glassmaking, not dependent on manual dexterity, is so difficult as to manufacture a *large* slab or disc of really good optical glass. Unless there is an overpowering proportion of lead, it will be deficient in refractive power; unless it is homogeneous and free from striæ, it will be useless. When the materials are fused, the lead, as the heaviest, has a tendency to settle at the bottom of the crucible, and if allowed to do so would completely destroy the homogeneity of the glass. The fused glass is, therefore, continually stirred until it has cooled to a consistency sufficiently thick to prevent the lead settling, and is then left still in the crucible to complete the cooling. When cold, the crucible is broken away, and the result is a cake of immensely heavy glass, of which it is not yet known whether the value is to be calculated in pounds or pence. After being re-heated till it is about the consistency of stiff dough, brought to the required disc-like shape, and again cooled, portions of the sides are ground and polished, and its quality is ascertained by examining it through a crystal of tourmaline, which detects at once any flaw in the homogeneity. If the flaws are many, the whole process has sometimes to be repeated, or, in some cases, the disc is broken up, and such portions as are free from flaws made up into smaller discs or slabs. If there are very few flaws, or only a single one, it is sometimes possible to re-heat the glass to a dough-like consistency, scoop out the peccant portion with an instrument something like a cheese-scoop, and fill up the cavity with completely homogeneous glass. The largest discs of such glass yet made, twenty-four inches in diameter, were manufactured by the Messrs. Chance some years ago for the French Government, which purchased them at £1,000 each.

Among the later improvements introduced into the flint-glass trade must be reckoned the application of steam to the processes of cutting, grinding, &c. It was first employed about twenty-five years ago by Mr. Benson, at Dudley, and Mr. Dovey, at Stourbridge. It is now universally adopted in the larger manufactories, but has effected no important modifications in the machinery for the various processes beyond supplying a new motive power.

On the whole, the most important experiment lately attempted has been the application of Siemens' patent furnaces to the manufacture. Messrs. Lloyd and Summerfield were the first to make trial of these furnaces in their works at Spring Hill, in 1861. Their example was followed in 1862, by Messrs. Chance, at Spon Lane, for the manufacture of sheet and crown glass, and a little later by Messrs. F. & C. Osler. Under careful and intelligent supervision, such as the furnace has received at Spring Hill, a considerable saving of fuel has been effected, although not so great as was at first anticipated. At Spon Lane the economy is less in proportion, as it has been found that slack or inferior coal cannot by any means always be substituted for the large coal employed in the ordinary furnaces. In the manufacture of crown and sheet glass, however, where the melting is conducted in open pots, the superior clearness of the glass obtained by this process is a powerful consideration in its favour, even if there were no saving of fuel. In the case of flint-glass, which is fused in close pots, and is consequently unaffected by the smoke of the ordinary furnace, this consideration is absent; and Messrs. Osler, finding that the saving of fuel and the greater control over the furnace obtained, were not sufficient to counterbalance the largely-increased cost, the liability to get out of order, and the strict supervision necessary, have now for some time abandoned the use of the invention. On the whole, the results of these trials have proved that Siemens' principle is capable of being applied to glass-furnaces with considerable advantage under certain circumstances, but further modifications and improvements in the practical arrangements appear to be required before the invention can be generally adopted with advantage for ordinary use.

The most striking improvement in the flint-glass trade during the last few years is to be found in its artistic development. This improvement, however, is perceptible throughout the manufacture, and is not confined to the Birmingham district. The principal features which have characterised it are the very general adoption of engraving instead of cutting as a method of ornamentation; the introduction of coloured glass in many instances, and the tendency to rely for effect rather on the beauty of form produced by the blower, than on display of merely manipulative skill on the part of the decorator. Engraving on glass, though it has only become common of late years, is an art of considerable antiquity in the district, having been successfully prosecuted at Stourbridge as early as 1660 in the hands of a foreign artist named Schinner. Among modern methods of cheap ornamentation should be mentioned that of etching patterns by means of hydrofluoric acid, employed for embossing window glass long before it was applied to flint-glass.

The repeal of the glass duty in 1845 produced, for a time, a considerable increase in the number of the smaller flint-glass houses, known in the trade by the name of "cribs;" but a decrease has since taken place, and the general tendency appears to be the concentration of the business in the hands of a few large manufacturers. In Birmingham there are at the present time seventeen furnaces of the larger sort in active operation, the annual produce of which may be taken in round numbers at five million pounds weight of glass. At Stourbridge there are twelve furnaces, yielding about three million and a half. In 1688 there were twenty-eight houses in operation at Stourbridge, and seventeen in the time of William III.; but the amount of glass produced has not probably fluctuated so greatly as the number of furnaces. In all, the manufacture at both places affords direct employment for about 1,500 workpeople, of whom about 900 are employed in Birmingham alone. Besides these, there are about 700 cutters and embossers in Birmingham, Stourbridge, and Dudley; about fifty engravers, and the same number of etchers, gilders, stainers, and painters.

Besides the ordinary descriptions of flint-glass, coloured glass of all kinds, both potmetal and flashed, is manufactured at Messrs. Lloyd and Summerfields, for railway and ship signal lenses, stained glass windows, various optical purposes, &c., &c., as well as for table and ornamental glass articles.

One speciality of the Birmingham glass trade, though of no importance as a manufacture, employing as it does not more than sixteen workpeople, deserves mention as a curiosity. This is the manufacture of glass eyes for dolls, dummies, wax-work figures, stuffed birds and beasts, &c., &c. The principal manufacturer is Mr. Charles Pache, of Lower Hurst-street, whose artificial human eyes for the use of those who may have lost one of their natural ones, are now the only articles of the kind made in this country, and are at once better and cheaper than those of French manufacture. This singular branch of commerce is of very recent date in Birmingham. It was suggested to Mr. Pache by the sight of some French artificial eyes in the Hyde Park Exhibition of 1851, and some years were spent in making experiments before he was able to imitate and surpass them. The ordinary glass eyes for stuffed animals have been made in Birmingham for many years. The business was once of sufficient importance to induce the Messrs.

Osler to attempt it, but it failed in their hands owing to their unacquaintance with the special secrets of the trade. The processes, however, are singularly simple, though in some instances requiring great manipulative skill. The workman is provided with a number of thin glass rods of the colours required. Heating the end of one of them by means of a blow-pipe, he "gathers" from it sufficient for his purpose on the end of a wire. This first gathering is generally of white or colourless glass, to form the white of the eye. He then takes the rod required to form the iris, and "gathers" from it on to the white; and lastly, a little spot from a black rod is added to form the pupil. During the process, the "gathering" on the end of the wire is rotated in the flame of the blow-pipe, and occasionally pressed against a smooth surface to obtain perfect evenness of outline. In spite of the skill required in the manufacture, and a considerable demand for the article, glass eyes are now greatly reduced in price, and the rate of wages of the few workpeople, half of whom are apprentices, is very low.

OPTICAL AND MATHEMATICAL INSTRUMENTS.

[ALTHOUGH not one of the great trades of Birmingham, optical, mathematical instruments, and spectacles especially, have for many years been manufactured here to a very considerable extent. Mr. Robert Field, whose Students' Microscope gained the prize of the Society of Arts, and whose business has been established more than sixty years, has furnished the Editor with most of the following facts relating to the above-named trades.

The manufacture of spectacles appears among the Birmingham trades as early as 1784, and was doubtless carried on some years earlier. The "goggle spectacles" of our grandfathers were made here in large quantities, and the patterns remained unchanged till about fifty years ago. Even as late as 1820, hampers of spectacles were sent away from Dudley Street, like packages of nails or chains, to be distributed throughout the country. The frames were large, thick, and clumsy, mostly of some sort of white metal, varying according to price. Mr. Lancaster and Mr. Godfrey were the first improvers, and as soon as steel wire became adapted for spectacles, a lighter and more elegant article was produced. At present there are at least ten manufacturers engaged in making spectacles, and about 200 hands are employed, Birmingham being the chief seat of the trade. Barometers and thermometers were first made in Birmingham at the close of the last century, and the manufacture took a very primitive form. An Italian, named Carlotti, and an Englishman, named George Western, used to make a few frames, and, providing themselves with the necessary materials, visit the neighbouring towns, and make up the instruments as required. The manufacture is now carried on to a large extent, and Birmingham produces more barometers and thermometers than any place except London.

About 1808, Mr. Philip Carpenter, the founder of the firm of Carpenter and Westley, commenced business in Birmingham in a more systematic manner than had been known before. Achromatic lenses had raised telescopes from mere toys to philosophical instruments, and Mr. Carpenter soon established a large trade, and supplied even Dollond himself with large numbers of telescopes bearing his famous name. In 1818, Sir David Brewster invented the kaleidescope, and Mr. Carpenter, being the sole maker, sent out large quantities for several years, till the cheap Nuremberg kaleidescopes were introduced. In 1826, Mr. Carpenter made the first solar microscope, which he took to London, and exhibited as the "Great Microcosm," and excited a great *furore* by its novelty and power. Sir David Brewster's stereoscope was first made for sale in Birmingham, by Mr. Robert Field, who succeeded to the business when Mr. Carpenter removed to London. The prize of the Society of Arts awarded to the present Mr. Field, some few years ago, in an open competition, is another example that for excellence as well as cheapness, a high class of instruments can still be produced in our town.

Mathematical instruments—the compasses, pens, sectors,&c. —have long been made in Birmingham in large quantities, but the manufacture of the commonest sorts has been much affected by the importation of cheap French and German goods, which are sold at very low rates. In consequence of the inland situation of Birmingham, nautical instruments are not produced to any great extent.

Machinery, although used wherever necessary, is not employed to any great extent; the chief requisites being careful finish and delicate skill. Women and girls are employed chiefly in the manufacture of spectacles, but as their share of the work is soon learned, they marry early, and are replaced by younger girls. The making of the light steel frames, now popular, and of the silver and gold frames too, employs men and boys, while the grinding of the glasses and the fitting up of the spectacles is frequently done by women and girls. Few trades have advanced as rapidly during the last thirty years, and although the workmen do not earn very high wages, their labour is light and well paid, and many of them set up as "small masters," and carry on their business at their own homes.]—EDITOR.

THE REVIVED ART OF METAL-WORKING IN THE PRECIOUS METALS, BRASS AND IRON, ON MEDIÆVAL, OR TRUE PRINCIPLES.

BY W. C. AITKEN.

THIS department of Metallic Industry, which has now reached a prominent position in this town, is of comparatively recent introduction. It owes its existence, indeed, to the enthusiasm, energy, and perseverance of one who "should have died hereafter," Augustus Welby Pugin, whose earnest and unselfish efforts to restore Christian architecture in its full integrity have now, at last, received unqualified recognition. In the early part of his career, he had succeeded in impressing on some few admirers the truth of the principles he advocated with regard both to construction and style of architecture; but when commissioned to put those principles into practice, he found himself surrounded by difficulties on all hands. Not the least of these difficulties arose from the total obliteration of all the old true principles on which metal had been worked. Modern methods of production, readier, cheaper, every way more adapted to meet the demands of the present day, had been universally adopted, and not a single specimen was to be procured of metal-work in the style, and of the character, required. Such was the state of this art in England when Pugin first took in hand the great task of its revival.

In his journeyings through the length and breadth of the United Kingdom, and over the continent of Europe, in pursuit of the one great object of his life, he had studied and examined not only the architectural features of mediæval art, but every example of metal work associated with it, which time, the spoiler, and the Iconoclast had left. Modern gold and silver smiths, he felt, had ceased to be artists. The blacksmith's craft, once hardly less artistic than that of his brother artificers in the precious metals, had now become purely mechanical. The true character of metal work had everywhere been lost sight of. The press, with its punch and bed, had replaced the delicately beautiful process of saw-piercing; the stamp and die had usurped the province of the beater-up; chasing had degenerated into a mere process for giving a mottled appearance to portions of the surface of an object in metal, appropriate texture being altogether ignored; engraving, carelessly executed, had gone off into the region of *rococo*, or had been subverted into the production of meaningless scrolls, queer shells, and impossible birds; enamelling, in its true sense, was almost a lost art, and where practised was most imperfectly executed, the colours being confined to a translucent blue, and the black introduced in mourning rings and brooches; *repoussé*, in its delicacy and beauty, was only occasionally in its integrity practised in France, where it was revived in 1838. In brass-work, the colour, as well as the reflective and ductile properties of the metal, were all partially obliterated in the hands of the caster. It was dimmed by the acid finish produced by "dipping," and falsified by the process of bronzing. Iron, the national metal, worked by English blacksmiths of old into such quaint, graceful, curious, and involved forms, uniting ornament with use—or in the hands of continental metal-workers, Matsys, Peter Vischer, and Nuremberg artificers, forged into well-cover and grille, ornamental door-handle and floreated hinge, such as even yet, decayed with rust and broken, startle us with the artistic beauty of their conception, the boldness, freedom, and minuteness of execution—iron, so nobly employed of yore, had now, for all ornamental purposes, been consigned to the mere caster and moulder, and if hammered at all was only hammered into prosaic utilities.

But it was not enough to feel these things, and to have formed a clear conception of what should be but was not. Pugin's ideas might have passed with him to the grave, had not the great revivalist been brought face to face with the realiser—the designer with the producer. In 1838, Augustus Welby Pugin was introduced to John Hardman, of Birmingham, a manufacturer possessed of means and a thorough knowledge of metal-working—above all, an enthusaist, prepared to carry out, in the face of every difficulty, the conceptions of the artist-designer. The connection thus commenced, under circumstances alike honourable to both, rapidly ripened into the closest friendship, and terminated only with the too early death of Pugin. Such was the beginning of the revival which has now developed an important branch of industry, and exercised an influence on metal-working generally, closely akin to that of the Pre-Raphaelite movement on painting. It has had the effect of making metal-workers *think*, apparently for the first time for some centuries, and has been the means of creating a superior class of skilled artificers, who claim for themselves a special department of metallic industry. Wherever metal-work on mediæval principles is now practised, its origin can be traced to Birmingham as the parent stem, and a large proportion of the artisans first employed in it by other firms and manufacturers have acquired their skill and learnt the secrets of their art at the works of John Hardman. It is honourable alike to the adaptive capabilities of Birmingham artisans and the spirit of Birmingham manufacturers, that this town, so often stigmatized as the centre of the production of "lacquered shams," should have been selected by Pugin as the field for carrying out his conceptions, and that under the guidance of his genius it should have so nobly taken the lead in the production of realities.

The difficulties attendant on the establishment of a trade involving such a radical change in the *modus operandi*, and so many processes wholly dissimilar from those then existing and practised, may be understood by intelligent practical men, but can hardly be so by the uninitiated. The whole revival was a series of experiments. Three centuries of neglect, and the loss of old traditions which might have unveiled the secrets of the old artists, had left the whole work to be commenced afresh.

"A few years ago," says Pugin, in answer to a virulent attack made on him by a writer in the *Rambler*—

> "It was impossible to procure even the commonest articles of church furniture in any but the most debased style—not a carver in wood or stone; and in metal work such was the difficulty of procuring operatives, that we were compelled, for the first altar lamp ever produced by us, to employ an old German workman, who made jelly-moulds for pastry-cooks, as the only one who understood beating up copper to the old forms. . . . . We were compelled simultaneously to carry on works in masonry, carpentry, wood and stone carving, painted glass, encaustic tiles, incised brasses, metal work from the most precious to the most common, embroidery, silk-weaving, and brocades."

This necessity for reviving the old methods of working metals, &c., arose simply from the total inadequacy of the new methods to produce the same effect. It was only, however, when mechanical inventions intruded on the domains of art and tended to the subversion of the principles they were intended to advance, that Pugin considered them objectionable. Stamping, pressing, die-work, and casting he would not have rejected or objected to, simply because they were modern processes. He disliked them because they were in their very nature opposed to the true principles of art,—because their application and operation resulted in the substitution of monotonous repetition for beautiful variety—flatness for bold relief with all its attendant light and shadow—because they tended to encourage a cheap and false magnificence, and to degrade the principles of ornamental design in deference to the exigencies of a ready-made manufacture. In modern metal-work, too, as opposed to ancient or mediæval, a constant confusion of processes is perceptible in which the distinctive character of the metal is lost. What is cast should have been beaten, and what is beaten should have been cast. The old workers never, or very seldom, committed errors of this kind. The fitness of the metal for the purpose intended was one of the first considerations; thus, portions of metalwork to support weight perpendicularly, such as columns, &c., would be generally cast, and afterwards engraved or chased. Due regard was also paid to the value of the metal employed. Bronze, a mixture of copper and tin, would be cast, while gold and silver would be beaten. Iron, again, would be enhanced in value, not by casting, as in the case of the minute Berlin ornaments, but by taking advantage of its ductile and fibrous properties, and the facilities it presented when heated for the operations of the hammer-man. That iron was thus manipulated as a metal for the display of cunning workmanship, instead of being cast, did not arise from ignorance of the casting process. Boutell mentions a cast iron monumental slab at Barwash, in Surrey, bearing a cross and inscription in relief, which sufficiently attests the skill of the mediæval casters. The preference shown for hammered iron was due to their understanding the fact so eloquently stated by John Ruskin, that—

> "Iron is eminently a ductile and tenacious substance, tenacious above all things, ductile more than most. When you want tenacity, therefore, and involved form, take wrought iron. It is eminently made for that. It is the material given to the sculptor as the companion of marble, with a message from the lips of the Earth-Mother:—'Here's for you to cut, and here's for you to hammer. Shape this; twist that. What is solid and simple, carve out; what is thin and entangled, beat out. I give you all kinds of forms to be delighted in—fluttering leaves as well as fair bodies; twisted branches as well as open brows. The leaf and the branch you may beat and drag into their imagery; the body and brow you shall reverently touch into their imagery. And if you choose rightly and work rightly, what you do shall be safe afterwards. Your slender leaves shall not break off in my tenacious iron, though they may be rusted a little with an iron autumn.'"

This poetic expression of the fitness of different materials for different purposes is strictly in accordance with mediæval principles, as is the following account of the characteristics of Gothic ornament :—

"While other styles of ornament (says the same author) indicate softness and beauty, and soothe like the melody of sweet music, that of the Gothic startles like a clarion's note or the trumpet's call, for it had its origin in the industry of the tribes of the North, whose energies were quickened by the coldness of the climate, which, consequently, gives expression in all they do, as opposed to that of the langour of the Southern tribes; and however much of fire there may be in the heart of that langour, even lava itself may flow languidly. Activity, united with rigidity, is a leading characteristic of the mediæval workman; but the rigidity is of the kind which gives tension to movement and stiffness to resistance—which makes the lightning forked rather than curved—the stoutest oak branch angular rather than bending. It gives a firmness analogous to the long skeleton of man, united by the muscles, or the fibres of wood in the tree. Gothic ornamentation ever stands out in prickly independence and frosty fortitude, jutting into crocket, and freezing into pinnacle; here germinating into a blossom; there knitting itself into a branch, alternately; thorny, bossy, and bristling; writhed into every form of nervous entanglement; but even when most graceful, never languid, always quickset, erring, if at all, ever on the side of brasqueness."

The main principle, in fact, of mediæval metal work, was to construct firmly and substantially that which was afterwards adorned appropriately and beautifully, keeping ever in view the purpose for which the object was intended, and the futility of decoration, except as subservient to, and growing out of, the construction.

When Pugin and Hardman first attempted to reduce this principle to practice no effort was made to start a manufactory, but the several objects were made by workmen selected for superior skill, taste, adaptation, talent, and ingenuity. The earliest objects produced were small in size, and chiefly of the precious metals—hanging lamps, candlesticks, chalices, flagons, metal mountings for books, mitres, pastoral staffs, &c. On these various and dissimilar objects were lavished much cunning workmanship on the part of the artificer, and much care and attention on the part of the designer, to whose revision and scrutiny they were subjected at each stage of the processes through which they passed. When of gold or silver, they were raised from thin plates of metal embellished with surface ornament by beating up. Delicate filigree work was associated with beautifully reticulated lace-like perforations, produced by saw-piercing—engraving, carefully and painstakingly executed, with richly hued stones, not facetted but polished—enamels of various tints, with brilliant surfaces of gold or silver, or the contrast of both produced by parcel gilding. The visions of the revivalist were realised in the triumph of the producer and and artisan. It is no figure of speech to say that these early works were indeed labours of love. The work had been done for the work's sake. The revival of the processes employed by the metal-workers of the olden time had, after much travail, pain, and sacrifice, been accomplished, and Pugin's long-cherished day-dream had at last become a living reality.

In 1845, the craftsmen engaged on these experimental works were concentrated in a single establishment in Great Charles-street, where Messrs. John Hardman and Co. thenceforth carried on business as ecclesiastical and civil metal-workers. In 1849 they added glass-painting in the styles of the 13th, 14th, and 15th centuries to their other business, and thus founded the first establishment for the production both of metal-work and glass on revival principles.

On Pugin's death in 1852, his gifted pupil and son-in-law, Mr. J. H. Powell, undertook the artistic direction of both departments, and has ever since most ably maintained the high reputation of the establishment, in which were produced, chiefly under the superintending eye of Pugin, the metal work of the new Palace, at Westminster, for Alton Towers, Lismore Castle, and a number of other buildings public and private.

That metal-work, misnamed Gothic, had previously been attempted is true, but neither in conception, design, nor execution did it approximate to mediæval metal-work. Such was the prevailing oblivion of all true principles before the era of Pugin, that any work, however preposterously it might outrage all the fundamental canons of art, was considered excellent Gothic, provided only it displayed a sufficient amount of cuspings, crockets, finials, and grotesque masks. Works of the period on Gothic architecture supplied the details of buildings erected in stone and lime, from which the designs for these astonishing works in metal were cribbed without hesitation. Thus an altar-tomb, originally built up and carved in Purbeck marble, furnished the model for a clock-case; a popular "door-porter," or weight to keep open a door, was fashioned in the likeness of the gable-end of a mediæval house, plus a long handle protruding from the finial of the said gable, while the same design, minus the long handle, did duty for a thermometer-stand; French lamp-heads towered aloft on three or four united pillars surmounting a base formed by four "Gothic" gables, a "Gothic" doorway being introduced in each panel, and the panels themselves rising from a plinth: "Gothic" inkstands, "Gothic" letter-weights, "Gothic" match and spill-boxes, "Gothic" fenders and grates of a like character were also all elaborated by casting, and perpetuated in manifold and melancholy numbers and variety. "Birmingham Gothic," of this kind, received at the hands of Pugin the severest of castigations, but not one whit more severe than it deserved. The producers of these monstrosities, in fact, totally misunderstood or ignored the properties of the material in which they worked. They went to work as if the qualities of metal were the same as those of stone or wood. No mediæval craftsman could have erred so grossly and so wilfully. The Gothic metal-worker never would have adopted a stone or wood treatment for his material. He would never have cast his cusps and crockets. He would have hammered his metal thin, marked the outline of the leafage, cut the pieces from the sheet, and beat them up into their manifold involved forms of curve and quirk and twist. Stone, he knew, was granular, and only partially cohesive; wood fibrous, but weak; bulk was required to give strength to both. Metal, he knew, was tenacious and ductile, strong in its lightness, and as he knew so he wrought. If he worked in brass, the structural part, where strength was required, was cast, and the ornamentation produced from thin plates of metal. Light and shadow he obtained with the hammer, bossing portions of the leaves up into convexities on the one side with their corresponding concavities on the other, curling the petals of his blossoms, expanding those of his flowers, working carefully over every portion of the object before giving it the final polish which should show off to best advantage its gold-like colour and reflective sheen, when flashing in the sunshine or glistening radiant in the light of sconce, corona, or candelabrum. There is no reason to suppose that the mediæval metal-workers were ignorant of the action of acids on metal, which was as familiar to the alchemist of the misnamed "dark ages" as to the chemist of to-day. But the workman of the middle ages refused to accept a mode of finish which at best could only approximate to the characteristic brilliancy of the metal he wrought. He deliberately preferred perfection achieved by painstaking care to a false finish effected by an easy process.

Was bronze the metal to be wrought? One of the distinctive characteristics of bronze is to blacken on exposure to the atmosphere. Be sure the mediæval craftsman did not forget this peculiarity. He cast his bronze in moulds, he graved it with chisels of various forms, he riffled it and left it in its massiveness and grandeur. Thus wrought Michael Angelo a statue to guard the tomb of a vicious Medici, with gaze on countenance "fascinating and intolerable." Thus Ghiberti, the everlasting portals storied with scenes from Holy Writ, which grace the Baptistery at Florence. Thus Cellini his Perseus and Andromeda. Thus Donatello his work now at Padua, in commemoration of Erasmo de Nari, who led the armies of Venice to victory. Thus Torrigiano, the metal-worker, for the monuments of Henry VII. and the Duchess of Richmond in Westminster Abbey, the Santa Croce of England. In each and all these works just so much finish was given as would secure the right effect, and they were then left for time to tone and colour.

Iron, again, was treated in strict accordance with its peculiar properties, and a distinction was drawn between works executed for various purposes. Thus pieces of iron-work for external decoration were bold, firm, pronounced, both in design and execution. The expression left no doubt as to the metal worked. Every advantage was taken of its "nervous-fibrous" structure. The crestings which broke the sky-lines of mediæval roofs stood out against the blue sky with a demonstrative energy which proclaimed at once the metal thus dragged into form, beaten against its will into spire and spike and stem and leaf and blossom, by a will and intelligence which stamped visibly in the marks of the hammer the evidence of its presence. In works to be seen nearer, a more perfect finish was given, but the same principle held good. The iron treatment was not to be misunderstood. Mediæval principles of construction themselves encouraged the desire for ornamental iron-work. No architect would have designed a door to hang on butt-hinges. He would never have secreted a mortise-lock in its side, or stuck on it knobs of glass or china. The floreated hinges he attached to his doors not only adorned but strengthened them and exercised both the designing power of the architect and the skill of the artisan. Biscornette's hinges, on which hung the portals of Notre Dame, were so curiously wrought as to suggest the idea that they had not been produced by merely human hands. Locks, too, boldly asserting themselves on the exterior of the door, afforded another opportunity for the display of cunning workmanship in iron mouldings, quatrefoils, and floreations, or not unfrequently told the story of the house and its founder. The bolts were turned by pendent handles elaborately worked, and the keys presented yet another field for the exercise of the iron-worker's skill. Even nail and bolt-heads assumed ornamental forms, and added beauty to the doors they protected and strengthened. Grates were then not constructed of cast but of wrought-iron. The andirons, or "dogs," often bearing the heraldic emblazonment of the family, were examples of appropriate ornament, and the fire irons were in unison with the other accessories of the hearth. Exterior and interior railings, in like manner, were always of wrought iron, the work of the hammer-man and fitter. If of round iron, they were intertwined; if of square, adorned by twisting certain portions of the bars while hot. The terminals were honestly worked. Transverse bars, when these occurred in pairs horizontally, were enriched by rosettes and heraldic shields. When tracery was introduced it was wrought in plates of metal, variously perforated and laid over each other. Imitation vegetation was cut out of thin iron, and twisted or bent with pliers; the leaves, veined by the graver or chisel, being welded or soldered to the stems. As all hand-work bears evidence of its origin, so also does machine-work. Molten metal flowing into a matrix by its own gravity can never rival the results produced by the skilful hammer-man. Cast iron as you may, carve or model patterns, mould them elaborately, produce relief by false coreing, the result will never be aught else but cast-iron, fragile, snapping at a touch, each piece hateful to the artist's eye from its stereotyped similarity to its fellows. Similarity produced by hand-labour is similarity with diversity, uniformity without monotony. The work tells of the keen eye and cunning hand, of human will and intelligence intuitively acting on true principles, because comprehending the nature of the material and the object of the work. In cast-iron we recognise only the machine-made copy of a copy; in wrought-iron we feel the presence of the thought which the craftsman has stamped upon his work. One brings us face to face with matter, the other with mind.

The processes employed in the special department of revived metal-working are either formative or decorative. The former include casting, raising from thin plates of metal, and forging; the latter, principally employed upon the precious metals, are—

I. Engraving, or incising the metal by means of gravers into ornamental designs furnished by the artist. These incisions are frequently filled with various substances to render the engraving more distinct, or to add to the beauty and value of the object, the chief processes employed for this purpose being damascening, niello-work, and enamelling.

Damascening is filling up the lines made by the graver with threads or wires of gold or silver, the incisions being peculiarly cut, so as to hold the metal introduced when beaten into them. This process was formerly frequently employed in the embellishment of arms, armour, caskets, &c., formed of iron or steel.

Niello is a black metallic substance, produced by melting and mixing together silver, copper, lead, and sulphur. The product, after being reduced to powder, is applied to the lines of the engraving and fused into them by heating in a muffle. The niello is then ground down to the surface of the metal, and the whole is polished. By filling the incisions with printers' ink in taking proofs for niellos, Finiguerra originated copper-plate printing in 1452.

Enamelling consists in fusing glass or other vitreous substances, coloured with various metallic oxides, into the incisions; opaque enamels are produced by the addition of oxide of tin to the mixture. Enamels are applied by three distinct methods, producing the varieties known as encrusted, translucent, in relief, and painted. With the latter, however, we have little to do. It was chiefly, and most successfully practised at Limoges, and bears a close relation to enamel painting as applied to glass and pottery. The enamels with which the old metal-workers had to do, and the use of which Pugin successfully laboured to revive, were the cloisonné, the champlevé, and the encrusted. The cloisonné is produced by fastening together with hard solder slender strips of metal which formed the outline of the subject to be represented. This metallic outline is soldered on a plate of metal, frequently gold; and before filling with enamel much resembles a pastry-cook's shape, for cutting leaves, &c. The spaces, or cells, are then filled in with enamel of various colours. The champlevé, on the contrary, was produced by cutting the design into the surface of the metal, the spaces to be filled with enamel being sunk, and the portions intended for the outline, or to separate the colours of the enamel, being left standing. The enamel, itself, is reduced to a granulated powder, and in this state is applied with a small spatula. When the incisions or troughs are filled with the various colours, the work is placed in a muffle, which is heated sufficiently to fuse the enamel into the spaces, the use of a muffle being necessary in order to prevent any injurious gases evolved by the fuel coming in contact with the enamel and spoiling its purity and brilliancy. If, after fusing, the surface of the enamel is too far below the walls of the cell prepared for its reception, more is applied and fused. The whole is then ground down to the level of the surface of the metal, polished with hones, and finally "lapped" to secure brilliancy of finish.

Encrusted enamel is applied to the surface of the metal without engraving, the various objects represented, leaves, fruit, flowers, figures, &c., being rendered in their natural colours. In this variety, the enamels are left with the "fire-glaze" produced by fusing still upon them without any after-polishing.

II. "Filigree-work" is the formation of certain portions of ornament from twisted wires, or wires twisted together into geometric or other designs.

III. "Saw-piercing" is sawing minute geometric or other ornamental apertures in thin plates of metal, so as to produce a reticulated appearance. The workman sketches his design on the metal, drills holes wherever necessary, passes his delicate saw through the holes, and with its assistance detaches the surplus metal as his drawing or his taste may dictate. This process is represented in modern metal-working by "piercing" effected by punch and bed, a purely mechanical process, which can no more reproduce the infinite variety obtained by saw-piercing than cast iron can imitate the effect of wrought.

IV. "Beating-up," "bossing," or "Repoussé work," by which designs in low or high relief are produced, is a charmingly artistic and effective variety of ornamental metal-work. The article or portion of an article to be worked having been "raised" into form, and the design traced, the parts which are required to be convex are punched up from the interior. The article is then filled with pitch, and worked on by the beater with variously-shaped small punches till the design, foliage, geometric ornament, figures, or whatever it may be, is sufficiently made out. It is then worked upon with small riffles, texture is given by matting tools, or the forms and details are finished with the graver. Opposed to this is the modern method of stamping with dies, objectionable on account of the want of relief, sharpness, and finish which all die-work displays, as well as the constant repetition of the same forms, which the expense of sinking new dies necessarily involves. Stamping, in fact, is the mortal foe of variety and originality of design, and the "beaten" work is as infinitely preferable to the products of the stamp and die as saw-pierced work is to those of the "press-tool" and "bed."

V. Gilding.—The revivalist still prefers the old amalgam process to electro-gilding on account of the superior durability of the work. A paste composed of gold, in combination with mercury, is applied to the surface to be gilt. The mercury is then evaporated by heat, and leaves the gold firmly adhering to the metal.

"Parcel-gilding" is chiefly introduced in articles of silver where additional richness is desired, as in the knob or boss, and the cup of a chalice. It consists simply in gilding the portions intended to show as gold.

Burnishing is still, as in mediæval times, effected with burnishers made of hard stone, agate, bloodstone, &c. Brass, it may be observed by the way, was formerly, and is still by the revivalist, polished by abrasion or friction, after being carefully filed or scraped, ground and honed—no other method fully bringing out the true colour of the metal.

VI. In working iron, the methods adopted by the mediæval craftsman and his modern descendant were and are very various. In the case of locks, for instance, and their ornamental covers, while some were decorated with plates wrought in the ordinary way, others were sculptured in cold iron. Figures also were produced by the same means. In floreated hinges where veins, ribs, or mouldings occur, they were generally produced by striking the hot iron into a die, the strips or bars being bent into their convolutions or floreations. Leaves also, where foliage was introduced, were struck in like manner to produce the veins, and afterwards welded on to the stem. Occasionally, however, the veins, both on the stem and leaves, were sculptured, as were the birds and other adornments of the hinges on the doors of Notre Dame at Paris. The twisting of square bars, which gives such variety when introduced into railings, was effected by heating the bar at the part intended to be twisted, holding the bar in a vice, applying a wrench, and twisting the bar round. When the twist in one portion had reached the desired pitch the iron was cooled. If the work was inaccurate, the part was reheated, and the error rectified, or the part still hot was twisted more.

Until within the last thirty years, the limited styles of manipulation practised amply justify Pugin's remarks on the condition of iron-working at the time he commenced his revival. "Ironsmiths were artists formerly, and great artists too; but now-a-days, if you apply even to a 'capital hand,' to copy any ordinary piece of old iron-work, he will tell you he does a particular class of iron-work, and does not think there is a man in the trade who could undertake the job."

After a lapse of nearly thirty years, the art of revived metal-working has ceased to be a matter of observation or comment. The difficulties which attended its earlier existence are now almost forgotten, and processes are now practised as matters of routine which were then only re-discovered and mastered after sore labour and heavy sacrifice. In the present day, "doing the work for the work's sake," sounds almost a mere figure of speech; but, in simple fact, nothing short of good and earnest workmanship *can* execute work in accordance with true principles.

The experiments of the revivalists have long since developed a branch of manufacture too extensive to be confined to the establishment in which they were originally tried, and several others have been started for the production of a similar class of work, nearly all of which, however, trace their origin to some connection with the original house.

In 1849, the results of the early labours of Pugin and Hardman were first publicly shown in the Birmingham Exhibition of Manufactures, held in connection with the visit of the British Association, in a temporary building on the site of Bingley Hall. In 1851, the Mediæval Court in the International Exhibition displayed their united labours in connection with the works of other manufacturers in other materials, executed on mediæval principles. Up to this time there were no similar establishments for the production of metal-work in the same style. In the Reports of the Jurors on the Exhibition of 1851, full justice was at length done to the efforts of the revivalists, and the perfect intelligence with which the designs were made and the work executed were particularly pointed out. In the special class of metal-work for ecclesiastical purposes, it was remarked that continental productions displayed far less intelligence in design, and were throughout imbued with the peculiar character proverbially, though improperly, attributed to "Birmingham ware." The works of Pugin and Hardman displayed nothing of this character; and the skill and manipulative processes by which they were produced, were pointed out as being applicable to brass work in varied and ornate styles, while the admirable fitness of the works themselves for the purposes for which they were designed was clearly set forth. They were light, yet strong where lightness was an object; where strength was needed it was given; ornamentation grew out of construction, to which it was subservient. On comparison of these works with examples of ornamentation and execution exhibited by metal-workers in other styles, the Jurors observe that—"while the former are honest, useful, characteristic, and therefore beautiful, the latter are flashy and grotesque, full of little prettinesses, put together without any leading motive, and having no definite character or true construction;" a verdict worth recording, as clearly pointing out the distinction between works executed on the revived true principles and those "got up" on the false but ordinarily adopted principles of modern manufacture.

The innovations made by the revivalists with regard to processes, finish, &c., were, however, almost secondary to those made in form and construction. The accepted types of articles in metal work, whether for ecclesiastical purposes, for public or private buildings, or for domestic use, underwent a thorough revision. Carefully studied geometric ornament took the place of the nondescript florid style formerly in vogue, and substantiality and soundness in construction that of the old flimsiness and falsehood. In the hands of the revived metal worker the vessels of the sanctuary have become worthier of their hallowed intention and use, no longer as of old poorly figured with devices indicative of pagan, rather than of Christian worship, but meetly adorned with symbols of the sacrifice their contents are intended to commemorate and typify. In metal fittings for lighting, also, the same improvement is visible, and the revivalist has shown that even the unpicturesqueness of modern costume is capable of artistic treatment in the memorial brasses which again are beginning to adorn the pavements and walls of our churches and cathedrals.

Nor is the change for the better confined to ecclesiastical decoration. Wherever public or private buildings are erected in accordance with the intention of architects belonging to that school of which Pugin was the founder, the same influence is apparent in the metal work employed in the external and internal furnishings, or associated with the labours of the carpenter and builder.

The mistaken prejudice, too, which during the early years of the revival regarded its principles as merely subservient to the spread and exaltation of a particular creed, religion, or fancy, has long since almost disappeared. By laymen and cleric, by Churchmen High and Low, by Calvinist and Arminian, by Unitarian and Methodist, works are now demanded bearing the stamp of the revival.

> "Give all thou canst; high Heaven rejects the lore
> Of nicely calculated less or more:"

is no shibboleth of a creed, or war-cry of a party, but an axiom which all true men, wherever they may be found, are ready to accept. If religion be a truth, it is a mockery to introduce things false,—shams in material or construction,—into its temples.

Up to 1852, mediæval metal-working was confined to the establishment of John Hardman and Co. In that year three workmen, formerly in the employ of the firm, commenced business in Birmingham on their own account. Eventually, the partnership was dissolved, and the result has been that there are now four separate establishments in the town. Long before this time, however, as if Warwickshire, with its magnificent ecclesiastical and baronial remains of the mediæval period, were determined to show itself worthy to be the cradle of the revival movement, Mr. Francis Alexander Skidmore, of Coventry, in 1847, enthusiastically entered as a labourer in the same field, attracted by a powerful sympathy in taste and feeling with the revivalists. He was at that time engaged in the jewellery trade, and his earliest works were chiefly executed in the precious metals; but at a later period he essayed and accomplished larger works in other metals, the roof of the Oxford Museum, composed entirely of wrought iron; and the screens of Lichfield and Hereford Cathedrals, the structural parts of which are of cast, and the ornamental of hammered iron, adorned and beautified with other metals. Wrought on mediæval principles, these works admirably fulfil the purposes of use and ornament for which they were intended, and demonstrate how iron, the metal, par excellence, of the present day may, under skilful treatment, become the vehicle of artistic expression.

The demand for "revival" metal-work has now long since originated the establishment of other houses, in London and elsewhere; but it is satisfactory to trace to Birmingham the first foundation of a trade which substitutes the reality for the semblance, earnest and conscientious work for make-believe, and which has given a renewed vitality to the only true principles of metal working.

The production of such metal-work demands, as may be supposed, a far higher class of talent than that required in ordinary manufacture, and is consequently more costly. Not unfrequently, a single work exercises the skill of designer, modeller, repairer, chaser, saw-piercer, engraver, fitter, polisher, gilder, and burnisher; and more elaborate and costly works, in addition, that of enameller and repoussé-worker. Careful supervision of the work while in progress is of the utmost importance to secure a successful result. Such works, therefore, can never be cheap in the common acceptation of the term, nor can they be produced quickly. The demand for them, consequently, although extending, is practically limited to those whose taste is sufficiently educated to appreciate them, and whose purse is long enough to purchase. Cheap metalwork, mis-named Gothic, is no doubt plentiful enough, with quite a profusion, may be, for the money, of cuspings, finials, foliage, and flowers; possibly, if of brass, beaten, polished, and lacquered; or, if of iron, scumbled over with paint to hide defective workmanship; but where is the vivifying spirit which permeates that which it attempts to imitate? The leaves look as if cut by tinmen's scissors, and the "beating" is nothing more than the administration of two or three blows with a round-faced hammer on a wooden block. Even at the best, these works are

> "So coldly sweet, so deadly fair.
> We start, for soul is wanting there!"

They are Gothic only in name, and no architect who wishes to carry out his work in the true spirit of the mediæval artist is justified in condescending to adopt them.

At the present time not fewer than 300 craftsmen are employed in the production of mediæval metal-work in Birmingham as designers, modellers, casters, fitters, workers in gold, silver, brass and iron, painters, enamellers, and engravers.

The difficulty experienced in arriving at the origin and early history of the several separate branches of the brass-trade in Birmingham has induced the writer to record, for the benefit of future enquirers, the rise and progress up to the present time of the revived art of metal-working. The restoration of this art in its integrity has been effected by the earnest labour, sacrifice, and love of John Hardman; and at the cost of a precious life, that of Augustus Welby Pugin, to whose memory is dedicated this account of the art of working in the precious metals, brass and iron, on those true principles which he was the first in modern days to enunciate, and his friend to carry out in practice.

BIRMINGHAM COINAGE.

By RALPH HEATON.

The process of coining, in the early periods of our history, was doubtless simple and rude in the extreme. In the earliest known coins of Britain the devices have been identified as having originated in the coin issued by Philip of Macedon; but so little did our ancestors then know of the art of punching or engraving dies, that the designs, if they may be dignified with that appellation, consisted of a mere grouping, almost without order, of circles, crescents, and other marks, so that were it not that the several links have been found to connect them with the coin of which they were debased copies, no one could even suspect that they were intended in the remotest degree to resemble it. Indeed, so completely did they at last depart from the faintest similitude to the human head, that a mere ornamental design took its place.

But whilst the engraving of the dies was executed with greater or less artistic skill, according to the state of civilisation of the country in which they were produced, in one respect no nation seems to have been greatly in advance of another, that is in the making of the coin itself. The method followed seems to have been simply to beat the metal into thin plates, shear it into blanks, and then, placing them between the two dies, force up the impression by striking them with a hammer. As a natural consequence of this primitive manipulation, the edges of all these ancient coins are rough, uneven, and present no regular outline. Even this, however, was an advance on the still earlier plan, which consisted in making the metal into a round ball, which was flattened and received the impression at one and the same time. Such coins had the device on one side only, the back retaining the mark of the punch by which it was secured while being struck. Not only the mechanical appliances of the mints, but their constitution in these times seems to have been marked by simplicity. Besides the King, who maintained numerous Royal mints, prelates and others exercised the privilege of coining money, even to the reign of Henry VIII., when private mints were finally abolished. The royal mints also became gradually reduced in number, and were at last consolidated into one establishment.

Little improvement seems to have been made in the art of coining, mechanically, until 1628, when Nicholas Briot, a native of Lorraine, was established at the Tower Mint, and introduced machinery for making the coins more perfectly round than they had ever been before, hand labour thus being, to a great extent, superseded. In 1662 still greater improvements were effected by the introduction of new machinery, by Blondeau; and lastly, early in the present century, the new and extensive premises on Tower Hill were built, the machinery, with its numerous improvements, being chiefly supplied by Matthew Boulton, of Birmingham.

Passing to the history of coinage in this town, it will be abundantly apparent that, however much it has deserved the opprobium attached to it as the chief centre for the manufacture and issue of "Birmingham halfpence," it has in no small degree been instrumental in keeping this country, and, indeed, a great part of Europe and the rest of the world, supplied with small change of a legitimate character, without which the retail transactions of every-day life must very soon come to a dead stop. And here we may remark in passing, that copper pennies were not issued from the Mint until 1609, and copper halfpence and farthings not till 1665, when they were struck by the new presses of Blondeau. The very name of these latter coins recals the early days when the silver pennies were struck with a deeply indented cross, so as to be readily broken into literal half-pence, and quadrant-shaped "fourthings" or farthings. It was not till the employment of copper money offered an opening for the peculiar ingenuity of Birmingham metal-workers, that the connection was established between our town and the current coin of the realm, which in its legitimate and illegitimate developments has conferred upon us such lasting discredit and such lasting honour. For many years previous to 1818 the want of copper money had been supplied, to a large extent, by the issue of tokens, not only by corporations, but in numberless cases by individual tradesmen and others who had their tokens struck with their names and addresses on, or such various devices as fancy dictated, a kind of currency which even at the present day prevails in Australia and other places where money of the lower denominations is scarce.

In the manufacture of these tokens Birmingham took a very active part, though to what extent they were issued it is perhaps not now possible to ascertain. The quantity, however, must have been very large. In 1817 was passed "An Act to prevent the issuing and circulating of pieces of copper or other metal, usually called tokens," which declared such tokens to be illegal on and after the first of January, 1818, special exceptions being made in favour of the Overseers of the poor of the parish of Birmingham,* who were allowed till 25th March, 1820, to recal their tokens, and the Overseers of the poor of Sheffield till 25th March 1823, since which dates no coin has or can be legally taken or tendered in payment but such as is struck and sanctioned by royal authority and proclamation.

But though private tokens have thus passed into disuse, it is to be remarked that the coin now in circulation is not, gold excepted, really of the value it represents. Thus, 20*s*. nominal value of our silver coin is not worth much more than nine-tenths that amount, and no more than 40*s*. in silver can be offered as a legal tender; while in the case of copper, the real value of a penny has so varied by successive alterations in the weight, that it seems to have been regulated, and properly so, purely as a matter of convenience. In the recent new coinage of bronze, for instance, the weight of the penny is exactly one-half that of the previous issue of copper. The amount, as a legal tender, is limited to 2*s*. Our currency, therefore, with the exception of gold, is a mere token system. Leaving now, however, the more valuable metals, we may confine our further observations to the copper coinage alone, since it is in this department that Birmingham has taken so prominent a position. In our day, though we have sometimes felt inconvenienced by a scarcity of this most useful small change, we can hardly realise the full meaning of being almost deprived of it altogether. Going back to the early part of the last century, we read that "Ireland was so completely without a currency to conduct the smaller operations of trade, that labourers were paid by cards bearing the seals and signatures of their employers." Under these circumstances, an English mine proprietor obtained a patent to issue £108,000 worth of halfpence and farthings for Ireland, every precaution being taken by the Government to insure the goodness of the coin in every respect. So great, however, was the agitation in Ireland, and so mischievously did the notorious Dean Swift interfere by his most flagrant misrepresentations in the celebrated "Drapier Letters," that the English Government was obliged to give way to the popular clamour, and the patent was withdrawn.

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* Before the period referred to large quantities of paper, or rather card tokens, for two shillings and sixpence, five shillings, and one pound, were also issued by the Overseers. Some of these were on *leather*, one example of this class (dated 15th January, 1808) being in the possession of Mr. R. L. Grew.—EDITOR.

In the latter part of the same century, the well-known and justly-celebrated Matthew Boulton, of Soho near Birmingham, fitted up a mint for the coinage of copper, and from 1797 to 1805, coined under contract for the British Government upwards of 4,000 tons weight of copper coin, amounting, at its nominal current value, to nearly £800,000.

Besides these moneys for the advantage of the British Government, Mr. Boulton made large quantities of copper coin for the East India Company, as well as for other Oriental and European Governments, the amounts of which we cannot now ascertain.

The old Mint was in operation with greater or less activity until the year 1850, when it was dismantled, and the machinery sold. Most of the working plant passed into the hands of Messrs. Ralph Heaton and Sons, and in 1857 the building itself was pulled down, and not a vestige of the once-noted Soho Mint now remains.

From the peculiar nature of this article of manufacture, it is obvious that the trade must be quite exceptional in its character. Coin, of course, can be legally made only under very special and stringent restrictions; and, again, a coiner, though at times he may be working to the utmost capabilities of his machinery, at other times must be content to see it all standing still, and unprofitable it may be for many months together. For these, amongst other reasons, it is not everyone who will have the inclination to engage in the business, and from the time when Mr. Boulton's Mint ceased to work, until 1860, when a new Mint was erected by Messrs. Jas. Watt and Co., at their foundry at Smethwick, our Mint was the only coinage establishment in England, with the exception of the Royal Mint in London. It thus unavoidably happens that any history of coinage in Birmingham, however brief, necessarily assumes somewhat of a personal character. In the summer of 1860, we removed and enlarged our Mint to meet the enormous demand consequent upon the new coinages of copper and bronze money required for this and other countries. Changes of dynasties abroad rendered new coinages necessary, while established Governments were re-coining the old money in circulation. The enormous minting power of this town was thus called into full activity, and has been more or less fully occupied up to the present time. What that power is may be estimated from the fact that there are in our works eleven screw and twelve lever coinage presses, while Messrs. Jas. Watt and Co., at Smethwick, have eleven screws more, making a total at both places of thirty-four presses.

Glancing now for a moment at the work done since 1849, we find that it includes about 2,000 tons of copper and bronze for our own country, 1,400 tons for India, 700 tons for Tunis, besides an aggregate of more than 1,000 tons for other countries, including Turkey, China (Hong Kong), Hayti, Sarawak, Tuscany, Venezuela, Canada, Chili, &c. The amount of the above in nominal current value would be considerably more than a million and a half sterling. But this is not all. In 1861 and 1862 we struck 1,600 tons of bronze coin in Milan, for the new kingdom of Italy, under contract with the Government of Victor Emmanuel, the blanks being made in Birmingham, and sent out. A coinage of 750 tons was struck in Marseilles on the re-coinage of the copper currency of France, after the re-establishment of the empire. Adding about £960,000 for these two coinages, we get a total of copper coin supplied to different parts of the world amounting to about two millions and a half sterling since 1849, the weight being about £7,500 tons.

It must be remarked, too, that this represents only the finished coin struck in Birmingham or executed abroad by Birmingham contractors. In addition to coin, blanks, ready prepared for striking, have been supplied from this town during the same period to the extent of about 2,500 tons.

Large as these results appear it must be borne in mind that they extend no farther back than 1849. It has already been stated that about £800,000 worth of copper coin was made at Mr. Boulton's Mint between 1797 and 1805; but from this date to 1849, a period of more than forty years, we have no available means of knowing definitely what was done, though we know in general terms that the production was very large.

Several of these coinages possess an interest of some historical value; as, for instance, the contract undertaken by us, and carried out at Marseilles, was for a portion of the new coinage issued after the establishment of the second French Empire, under Napoleon the Third. Again, in 1859, the year of the Italian war with Austria, the Provisional Government of Tuscany determined to replace the Grand Ducal copper coinage by one of their own, which was also supplied by our firm. These coins bore, on the obverse, the arms of the King of Sardinia, with the legend :—

"Vittorio Emanuele Re Eletto ;"

and on the reverse :—

"Governo della Toscano ;"

with the value and the date in the centre.

When Tuscany became subject to Victor Emmanuel as part of a united Italy, this coinage was in turn superseded by that of the new kingdom, executed by ourselves, as contractors, but coined out in Milan, the blanks being sent from Birmingham, as already stated.

It seems scarcely necessary to remark that the coinage operations of Birmingham have their effect upon other businesses. No branch of trade, whatever be its nature, but must affect others connected with it, according to the magnitude of its transactions; and we need not expect that the one under consideration forms any exception to this general rule. The purchase of several hundred tons of copper, at one time, for conversion into coin, naturally exercises a direct influence upon the copper market.

Again, coin in any quantity cannot be struck without the consumption of a considerable number of dies, which must be made from steel of peculiar quality. Although the amount of steel thus used seems small in comparison, it yet forms a not altogether insignificant item; and when to the cost of the steel we add that of the labour expended upon it before it is in a form to give an impression, we find it amounts to a heavy sum. In the recent coinage of 1720 tons of new bronze for own country, more than 17,000 dies were used. These were supplied by the Government to the contractors, and could not be valued at less than 5*s*. each, making a total cost of something like £4,250 for dies alone. Usually, the contractors have to make the dies as well as the coin; and during a pressure the preparation of these finds employment for many hands, who are for the most part obliged to be skilful turners and men of some intelligence, since a badly-made die cannot of course produce well-made coin. The various processes through which the metal must pass in order to its conversion into coin will be found so fully detailed in "Ure's Dictionary," "Chambers's Encyclopædia," and other popular works, that to describe them here would be a needless repetition.

With reference to the workpeople themselves it may be remarked, that though in a general way a particular trade will stamp those who habitually work at it with a character of their own, there can scarcely be said to be any operatives specially belonging to the occupation of coining (of course we speak of Birmingham only, and do not include the Government employés in the Royal Mint), except, perhaps, the few skilled workmen who have the management and oversight of the various machines. Men for packing, girls for sorting and wrapping, and boys to feed the presses, are all required; but the employment being to some extent of an uncertain character as to duration, they are set on or cast off as necessity requires. Good character is in all cases indispensable, but the machines being essentially self-acting, but little mechanical skill, comparatively, is required for feeding and keeping them at work. Attentiveness, therefore, combined with ordinary common sense, to see that nothing goes wrong without being at once detected, is the chief desideratum in boys for this employment. The girls, for sorting the coin, throwing out imperfect pieces, and wrapping it in rouleaux, should possess, as a matter of course, the same qualifications.

The ages of these boys and girls may vary from about eleven to eighteen or twenty; and in education and social position, generally speaking, they differ nothing from the average in other Birmingham operatives.

[The Editor is indebted to Mr. Gilbert Hamilton (James Watt and Co.) for the following facts:—The Soho Foundry was established under this name by Matthew Boulton and James Watt, in 1797, on account of the difficulty of procuring castings from Wales. In 1848, on the death of James Watt, Esq., the son of the great engineer, the original and famous works at Soho were abandoned, and the machinery, &c., removed to Soho Foundry. In the same year, at the request of the executors of the late Matthew Robinson Boulton, Esq., who had retired some years before, his name was withdrawn, and the honoured title of "Boulton and Watt" became "James Watt and Co.," which is its present style. Besides the manufacture of engines (hereafter to be mentioned), this valuable contribution adds:—

"Another branch of our trade has been the manufacture of coining machinery, which was originally designed by Matthew Boulton, and made by Boulton, Watt, and Co., who supplied the chief of the Mints throughout the world with it, including Mr. Boulton's first and second Mints at Soho, and our own existing Mint *here*, as well as the British Mint in London, those at Calcutta, Bombay, in Russia, Portugal, the Brazils, Culiachan [Mexican], Hong Kong, Madras, and various other smaller ones, comprising, together, 108 Coining Presses, and the principal parts of the Machinery required for preparing the pieces to be stamped in them.

"In our own Mint here, the work of Coining has been carried on to a large extent, there having been finished in it, between 30th August, 1860, and 7th March, 1866, a quantity of Bronze and Copper Coin, weighing 3317¼ tons, and numbering 606,379,848 pieces, of which, on some occasions, as many as a million of pieces were made and packed in one day."]—EDITOR.

DIE-SINKING.

DIE-SINKING is an art which for more than two centuries has been practised in Birmingham, with very considerable success, as applied to purposes both legitimate and illegitimate. The processes employed are simple, though frequently demanding the exercise of great artistic skill and delicacy of manipulation. In ordinary cases, a piece of steel is cast of the shape required, round which a collar of iron is welded in order to prevent the steel cracking when hardened. The surface being prepared, the die-sinker sketches his design upon it and engraves it, employing for the purpose gravers, with edges of three different shapes, one straight, one straight with the corners rounded, and one semicircular; some forty or fifty sizes of each of these three kinds of gravers being required to suit the varying character of the work, and the special treatment demanded in the several portions of the die. When the engraving is finished the die is heated and suddenly cooled to harden it, the surface is polished by "lapping," and it is then ready for use in the stamp or press. Other subsidiary processes are employed in elaborate works, and in the multiplication of dies; but the accounts given of them in the Encyclopædia Britannica and other well-known works render it needless to do more than indicate the general *modus operandi.*

The almost endless variety of objects produced by stamp and press renders die-sinking a highly important branch of industry, although the number of articles that can be struck from a single die, and the ease with which dies can be multiplied from one original, prevent its being one that finds employment for more than a very limited number. As the die-sinker executes almost all, and in most cases quite all, his work for various manufacturing houses, he seldom gets the credit of his performance with the public. This or that well-known manufacturer, in Birmingham, London, or elsewhere, brings the finished goods into the market, often stamped with his own name, and absorbs the praise justly due to the artist or garret-master up an entry in a back street, who is the real author of the work. This absence of any direct communication between the die-sinker and the public, and the interest of the manufacturers who employ him in suppressing any mention of his name, have had a marked influence on the history of the trade; but that which has most affected it is the growth of what formerly were merely different departments of large general manufactories into separate and independent trades. When Boulton's manufactory, at Soho, for instance, was at the height of its extended activity, about the commencement of the century, coining, medalling, button-making, and a number of other trades, all demanding the labours of the die-sinker, were carried on simultaneously in the same establishment. Die-sinking, therefore, conducted on the premises, became itself no inconsiderable department of the manufactory. Now, however, each trade is specialised. Coining, button-making, &c., &c., have become wholly detached branches of industry, and, although each still requires the services of the die-sinker, scarcely a single manufactory can find continuous employment for even an individual artisan of this description. Die-sinking, in fact, is as a rule no longer done on the premises in large manufactories, or, if done on the premises, is done by workmen temporarily employed for the purpose. This splitting up of old departments into separate manufactures has reacted, also, on the larger die-sinking establishments formerly in existence. When the workmen employed on the premises of the older manufactories were set adrift, each had to find work for himself where he could, and began to compete with these larger establishments. The workmen thus competing had no "establishment charges" to pay, and could afford to work cheaper than the large houses. Profits were thus reduced. Die-sinking no longer offered the same inducement to men of large capital to embark in it, and for many years there has been no large "house" in the business. The die-sinker, eliminated from the regular staff of the large manufacturers, now works for several masters, and, except in the very rare cases in which he is an accomplished medallist as well, for the most part carries on his somewhat precarious trade out of sight and out of mind of the general public, as an out-door journeyman, or at best as a small master employing some two or three hands.

The principal purposes for which dies are required are—

I. Coining, of which a full account has already been given. This branch of the trade was exceedingly active in Birmingham during the whole time that tokens were in circulation. The only gold tokens ever struck were 800 forty-shilling pieces manufactured at Birmingham by the late Sir E. Thomason, for J. B. Monk, Esq., banker, of Reading, in 1812. The same manufacturer, in the same year, supplied 2,000,000 penny tokens for circulation among the British forces in Spain. The great iron-masters, however, were the largest issuers of tokens; those struck at Soho for John Wilkinson in the last century, and those struck by Thomason for Fereday in 1807 and following years, being still common in the neighbourhood. The issue of gold tokens was stopped by the Government at the outset, and that of silver, copper, and other metals was, with some temporary exceptions, declared illegal after January 1st, 1819. This particular department, therefore, which afforded a considerable field for the labours of the die-sinker, has long been in abeyance, and the only coin produced in Birmingham, with the exception of the work of the "smasher," has been the current coin struck for British and Foreign Governments. Identical with coining, so far as the labours of the die-sinker are concerned, is—

II. Medalling, in which, as in coinage, Birmingham has long asserted and maintained a foremost place. The number of purposes for which medals are required render this a very important department of the trade, as it is also the one which displays the talents of the artist to the best advantage. Many hundred varities of medals are annually produced in commemoration of events or individuals, victories or peaces, Royal births, coronations, marriages, and deaths, anniversaries of schools, chapels, churches, societies, and institutions of almost every kind—weddings, "silver" and "golden"—laying of foundation-stones, or inaugurations of public buildings—of every popular hero, from the Temperance lecturer, to the successful general, from Shakspeare to the "nigger melodist" of a concert-hall; or as decorations or prizes for schools and colleges, for cricket matches, and boating, rifle-shooting, and athletic games of every kind; or merely as objects of vertu without any special application to any particular event, past or present. It will be seen from this enumeration, which might easily be doubled or trebled, that medalling offers an unlimited field for the display of the die-sinker's skill in his craft, and in its higher walks at least demands artistic talent of a very high order. Almost every metal known to manufacturing industry has at some period or other been used for striking medals in. Most of the ordinary medals are struck either in bronze or tin, the latter, carefully refined by the medallist, being the familiar white metal of the common coronation and other medals. Medals in high relief require to be struck several times before the impression is properly brought up. In bronze medals the process of "bronzing," which gives their peculiar colour, is generally performed before the medal is struck for the last time. The demand for medals of a high class has somewhat revived of late years, though not even now so great as it was in the palmy days of Thomason. There is, however, considerable activity in other departments of the trade, and the general improvement of the community in artistic taste will no doubt eventually make itself perceptible in our coins and medals. In the days of Boulton, the Government called in the assistance of Birmingham medallists to reform the national coinage, and whenever another reform is contemplated it is to be hoped that the same course will be again adopted. Our bronze coinage, artistically considered, is a national disgrace which those in authority are bound, if not in conscience, at least in good taste, to remove at the earliest possible moment. The powers of conception, design, and execution which distinguished those artists of Soho, who in the last generation devoted their genius to raising the artistic character of the coin produced at the London Mint, seem, indeed, now to have deserted their descendants. But the medallists' craft has not degenerated in its former home, and Birmingham is still fully capable of again supplying, in this its own peculiar department of art, the deficiency of metropolitan talent.

III. Button-making.—The history of die-sinking in connection with buttons is sufficiently indicated in the account already given of the button manufacture. Livery buttons are now almost the only ones on which the labour of the die-sinker is expended, the figured gold buttons of the pigtail period, and the sporting buttons, both in horn and metal, fashionable in the early years of her Majesty's reign, many of them of exquisite workmanship and by first-class artists, have now almost entirely disappeared. Another large and important department has thus been almost completely annihilated, and its annihilation has, as usual, been attended by an overstocked labour market in other departments, and consequent fall of wages.

IV. Steel seals, both for individuals and companies, have, on the other hand, been in greatly increased demand of late years, the limited joint-stock companies alone furnishing no inconsiderable portion. The enormous development of the envelope trade, also, and the accompanying demand for stamped note-paper, have opened almost a new field for the die-sinker. The bulk, however, of this last business is in the hands of the London engravers, although a considerable number of the dies, especially for commercial work, bill-heads, envelopes, &c., are executed here, and, as usual also, much of the so-called London work is produced in Birmingham.

V. An immense variety of dies are produced for use in almost every branch of ornamental metal manufacture, which it would be useless to specify. They are of all sizes and all weights, from a couple of ounces to a couple of tons. It should be observed however, that these heavy dies are for the most part cast, and only finished, if finished at all, with the graver, or in the lathe. Among the largest dies principally worked by the graver, are those for brass handles and feet, and curtain-pole and cornice ornaments.

The difficulty of ascertaining the names of particular die-sinkers and medallists, when their works have been executed for large manufacturing establishments, has been already noticed. Some few, however, are remembered as artists of no mean repute, especially in connection with the establishments of Boulton and Thomason. C. H. Küchler, who sunk nearly the whole of the dies for the celebrated Soho coinage, and notably, for the well-known twopenny piece, worked mainly in the French style of Dacier. He was at one time living at 22, Bride Court, Fleet Street, where he carried on business as medal-engraver and die-sinker. After having been many years at Soho, he quarrelled with Boulton, and seems to have ended his days in straitened circumstances. He lies in Handsworth Churchyard, without a stone to mark his resting-place. At the time of his leaving Soho he had commenced the die for the celebrated medallion of Boulton, for finishing which Pidgeon afterwards received £300. Other foreign artists of signal merit were also employed in sinking dies for the various medals struck at Soho, among whom may be mentioned Dupré, Droz, and Desmarest. The first of the Wyons who distinguished himself in this line of art seems to have executed some works for Boulton, but is better known in connection with Thomas Halliday; Pidgeon, already mentioned; Mills, who was employed after Küchler's departure, and executed among other works a fine medallion of Watt. Philpp, Hancox, and Webb were also all skilful medallists employed at Soho. The last, who afterwards worked for Thomason, is mentioned by him as one of his best artists, and as having executed, in 1814, an excellent medal of the Emperor Alexander of Russia. At that time the beauty of many of the French Imperial medals had attracted much attention in this country, and a marked change is perceptible in the character of the highest class of English work executed after a study of the productions of Denon and other Parisian artists. Thomason, a pupil of Boulton's, started in business for himself in 1793, carrying on large works in Church Street till 1835, when he disposed of them to Messrs. Whitgrave and Collis. After Boulton's death in 1809, the principal medallic works produced in Birmingham were struck at Thomason's establishment. One of the finest of these was engraved by Wyon in commemoration of Boulton. It is four inches in diameter, and the largest of that size ever struck in such high relief. Besides a vast number of occasional medals, Thomason, in 1820, struck a series of forty-eight from the Elgin marbles, and shortly afterwards a series of thirty-two illustrative of the Sciences. These were followed, in 1830, by a series of sixty, three inches in diameter, of Scriptural subjects, the designs being taken from paintings by the old masters.

Among the die-sinkers not connected with these great establishments, should be mentioned Thomas Halliday, a very good workman himself, but a better judge of the works of others, who carried on business in Newhall-street, about the beginning of the century, and from whom nearly all the modern die-sinkers in Birmingham learnt their business. He executed some medallic work of an ordinary character, but the greater part of his business lay in other departments. Sheriff, of Snow Hill, is almost the only contemporary of Halliday still remembered as distinguished for his talent. At the present time, Mr. Joseph Moore, of Summer Lane, is the head of his profession; and as an artist and medallist is hardly surpassed by the best of his predecessors, either in power of design, or spirit and skill in execution.

PAPIER MÂCHÉ MANUFACTURE.

BY W. C. AITKEN.

THE papier mâché manufacture is a speciality of industry for which Birmingham has been long and deservedly famous. Nowhere else in this or any other country has an equally excellent quality of material been produced, and the decoration, if it has often transgressed the limits of good taste, has often also been designed in admirable accordance with the properties of the material and the surface decorated.

The invention of the material, as produced by pasting together sheets of paper, is due to Henry Clay, of 19, Newhall-street, in early life an apprentice to the celebrated John Baskerville, who, at that time, was engaged in the japanning trade. Long previous to Clay's invention, however, papier mâché had been made by reducing paper to pulp and pressing it into dies. Clay did not take out his patent till 1772. He formed the papier mâché by pasting together sheets of spongy paper over variously shaped "cores" or moulds of metal. At an early period he indicated the future extensive application of his invention for panels for chariots, cabins of ships, window shutters, mantle-pieces, tea-trays, card and dressing tables, and every other species of elegant furniture.[*] He also stated that it could be sawn, planed or turned like wood, and that after being japanned, it would be brought up to the highest polish by friction with the human hand. Many of the original articles made by him are still in use, and fully confirm the enduring character he claimed for his material.

Clay amassed a princely fortune by his manufacture, and this, probably, in connection with the plucky character of the man, raised him to the office of High Sheriff of Warwickshire, which he filled with credit in 1790. At one period 300 hands were employed in his manufactory, but in 1802, the number had been gradually reduced to less than 100. His profits were enormous. On a single tray, sold for £5. 8*s*. 9*d*., he made a profit of £3. 8*s*. 2*d*. He basked in the sunshine of royal patronage, gained by a judicious present of a sedan-chair, a vehicle now almost obsolete, to Queen Caroline. The panels of this royal gift were of papier mâché, and the present was supplemented by a set of pier or console tables, adorned with paintings after Guido. Nor was Clay's ingenuity confined to the production of papier mâché. He invented an improved wagon, opening in the middle, and a new canal-lock intended to save one-half the water, and enable the boats that passed to move more speedily. His London house was in King-street, Covent Garden. When his patent expired, the trade was extensively carried on by Small and Son, Guest, Chopping and Bill, and by their sons, who, in addition to the production of finished goods, commenced the manufacture of the papier mâché "blanks," which they supplied to the trade. From this firm arose the justly celebrated one of Jennens and Betteridge, now represented by Mr. John Betteridge. They began business in 1816. From the manufacture of tea-trays they proceeded to the production of other and various objects in the same material, their skill in making, and taste in decorating them giving a character to the trade which greatly raised it in public estimation.

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[*] After referring to the introduction of the trade, and solidity of the material, which "bears the operation of the same tools as those used by carpenters, joiners, and cabinet-makers, such as saws, chisels," &c., and to the patronage of his Majesty, the Birmingham "Directory," of 1780 adds,—"The articles made of papier mâché, at this [Clay's] and other manufactories of the town are tables, cabinets, tea-trays, cadees, panels for doors, coaches, chaises, sedans, and snuff-boxes," &c.

Up to 1836 large objects in papier mâché, such as panels, articles of furniture, tea-trays, &c., were made by pasting sheets of paper together on moulds. In that year Mr. Brindley introduced the manufacture of blanks, &c., from pulp formed in iron or metal moulds, the blanks being dried by heating in the moulds in which they were produced. The patent was contested, and thrown open in 1842. In 1845 the same inventor introduced a new method of producing blanks and portions of articles, by first forming the pulp into sheets, not pressing them between felt surfaces, as in ordinary pasteboard manufacture, but between metal plates, and then pressing the sheets into suitable moulds, to produce the form required. In 1846 he much facilitated the production of ornamental forms in papier mâché by the introduction of moulds with sunk or hollow parts, which produced ornamental parts akin to the carvings on wood furniture, &c.

In 1847, Mr. Theodore Hyla Jennens introduced steaming the blanks, and then subjecting them to pressure in moulds, thus securing a denser material and equal thickness in the blank.

Goods of the best kind are produced by attaching together sheets of a soft grey paper, resembling blotting paper, by a paste of flour and glue, on a metal body of some kind made so as to give the shape to the article required, between every sheet laid on this "core," which is the technical phrase for the metal foundation: it is then covered over, and exposed for some hours in a stove heated to 100 degrees to dry. It is then subjected to a rasping process, and sheet after sheet of paper is thus added, until the required thickness has been attained. The articles are then immersed in linseed oil and spirits of tar, to make them resist moisture, and then they are placed in another hot drying stove, of not less than 200 degrees, and not above 260. Again the inequalities are carefully removed by plane and rasp, and the article is formed as required, when it is then transferred to the varnishing shop, where coat after coat of tar, varnish, and lamp black is repeated until the surfaces of the goods are as level as possible, when they are stoved again for twelve hours. Any inequality being again removed, then the articles are introduced to the artist, who begins his more dignified operations upon them. The final finishing course is that of coating the work with transparent copal varnish, and then with the human hand, and a little rotten-stone applied with water, the last polish is given to the articles.

The "pulp" process consists in reducing paper to a clay-like consistency or viscid mass, or employing pulp not previously converted into paper, and compressing it in moulds by means of a hydraulic, screw, or other press. The superiority of goods formed from sheets pasted together is due to the homogeneicty of the paper from which they are made, as distinguished from the heterogeneous mixed material which forms the pulp. This difference is perceptible in the irregular surface of the latter, visible when the article made from it is finished. This irregularity arises from the presence of harder particles in the pulp, which the brilliant hand-polish, in finish, renders more apparent by making the surface reflective. The "best" papier mâché, made from pasted sheets, not only presents a flat unbroken surface, but is also lighter and stronger than that made from pulp, which is brittle in comparison.

The decorative processes employed have been considerably modified in the course of years. Bronze-gold, in the form of powder, associated with the brilliant blacks and other colours arranged in simple lines, formed the earliest kind of ornamentation. Copies of paintings had been introduced, we are told, in the pier-tables presented to Queen Caroline. About 1816, a peculiar method of decoration was adopted, executed in various-coloured bronzes without the introduction of pigment-colour. On the surface of black or other colour, the subject was painted in gold size, and the different bronzes were applied with small stump-like tools, the flesh tints being indicated with a reddish-hued bronze, and the draperies, &c., with varied tints. Of two examples recently examined, one represents the Goddess of Earth, in a chariot drawn by two chained lions, with two little Cupids as charioteers; the other, Daniel in the Lions' Den. Both were executed by an artist named Davis, who also gained some celebrity by his copies in the same style of rustic subjects by Morland, in which he carefully reproduced the touches of the original artist.

A decorative artist, named Joseph Booth, in the employ of Messrs. Jennens and Betteridge in the years 1821-2-3-4-5, was justly celebrated for his exquisite imitations of Chinese and Japanese ornament. He executed in 1824 a tray for the Prince Regent. The style in which he worked is familiar to connoisseurs. It consists of impasto work, afterwards worked upon with minute finish. Gold-size and whitening produced the elevated portions of rocks, tree-stems, pagodas, bridges, &c.; the foliage and other details were pencilled on with the most delicate of touches. One example, at least, still in existence, demonstrates his rare ability. The best judge must have failed to distinguish the imitation from the original work of Chinese and Japanese artists.

Pearl-shell inlaying, which contrasts so well with the brilliant black of English papier mâché (a process suggested by foreign lac-work) was introduced by George Souter, also a decorator in the employ of Messrs. Jennens and Betteridge, who patented the invention in 1825. The pearl ornaments were made from thin laminæ of shell, from one-hundredth to one-fortieth part of an inch in thickness. The ornament was painted on the pearl with varnish or "stopping-out" material; acid was then applied, and the portions of pearl not protected eaten away. By this method the most delicate ornaments were produced—very much more delicate than those which can be wrought by saw-piercing or cut with press-tools, which last method was adopted to evade Souter's patent.

This process is familiarly known as "inlaying," to which title, however, it has no claim. The work is not inlaid. The pearl-shell ornaments are stuck on the ground of the partially formed article to be decorated, by means of copal or other varnish. When they are all arranged, repeated coatings of tar varnish are applied, which fill up the interstices and gradually cover up all the pearl. The superfluous varnish is then removed with pumice-stone and the ornaments displayed. The object is then polished with rotten-stone, and in this state is ready to receive the additional gold or other decorations.

In 1844 the desire to produce something new induced Mr. Farmer to associate electro-deposit medallions with *papier-mâché* in salvers, card-baskets, portfolios, &c.; and in 1846 a new style of pearl-shell decoration behind glass was introduced by Thomas Gibson. This process consists in executing the subject in gold or colour on glass, leaving the space under which the pearl-shell is to be introduced untouched, or in other cases, glazed with transparent varnish colour, which allows the iridescence of the pearl to shine through it. After attaching the pearl to the glass by means of transparent varnish, the panel or slab is backed up, and introduced into the lid of desk or dressing-case, fire-screen, or chess-board, &c. Attempts were made to infringe this patent also, by the introduction of coloured foils behind glass.

"Gem-inlaying" was invented by Benjamin Giles, and patented by Theodore Hyla Jennens, in 1847. It differs from Gibson's patent only in the substitution of stones of various colours, coloured glass or paste, or in some instances real gems in the place of the pearl-shell, and in executing the work on the reverse side of the glass. Spaces are left in the decoration for the introduction and attachment of the stones, &c., &c., by means of varnish, the colour being heightened by the introduction of coloured foils behind them as in jewellery settings. This style of decoration, where it can be applied, produces a rich and brilliant effect. Singularly enough, eighty-six years ago one Thomas Skidmore applied pastes and stones in a nearly similar manner to the same materials.

In 1864, Mr. John Betteridge—on the reduction in the cost of aluminium consequent on the experiments of Clair Deville, (which resulted in Messrs. Bell, of Newcastle-on-Tyne, entering largely into the manufacture)—applied that metal, and bronze formed from it, to the decoration of envelope-cases, card-trays, binding for albums, &c.

All these methods of decoration involve the employment of hand labour. The various mechanical methods of ornamentation may be more briefly recounted.

The transfer of gold to papier mâché by mechanical means was first accomplished by Mr. C. Breese in 1853, who has since achieved celebrity by the production of instantaneous photographs, reproducing the most transient effects in nature.

In 1856, Samuel Tearne and G. Richmond introduced a colour transfer process, by which a design printed from a series of coloured stones, as in chromo-lithography, on tissue paper, could be transferred to papier mâché, or iron goods, the removal of the paper, as in pottery printing, leaving the design in all its details of colour, &c., on the object to which the transfer had been made. The perfection of the work by this process depends principally on the skill of the printer, very little, if anything, being left to be finished by hand with the pencil. Those who have experimented on "Diaphanie" will readily understand the process, which only differs from it in employing transparent colour.

Besides the ordinary articles for house-consumption, large quantities of panels for steam-boat cabins, dining-room furniture, &c., are made for the export trade to Canada, North and South America, Russia, Spain, &c., besides an immense variety of large pieces of household furniture, wardrobes, loo and other tables, dressing-glasses, sofas, &c., decorated to suit the taste or the want of taste of purchasers in the countries to which they are exported. Of these Messrs. McCallum and Hodson are large producers.

The style of ornamentation adopted in these articles has, there can be little question, materially injured the trade, by fostering a taste for exuberant decoration, opposed to all true principles of ornamental art. It is satisfactory, however, to know that if articles in good taste are required they are to be obtained. The successor of the old house of Jennens and Betteridge, which was practically the first to raise papier mâché goods to the rank of genuine art manufactures, still worthily maintains the credit of his predecessors.

Birmingham has never yet been rivalled or approached in the manufacture of papier mâché. The French have attempted it, but they signally fail in the material, and more curious still in the ornamentation. In the Report on the Paris Exhibition of 1855, it is observed that "the examples exhibited in the French and German departments bore marked evidence of improvement in some of the best articles; but with all their artistic errors the Birmingham productions were certainly very superior in point of workmanship and finish to any other works of the class." The remarks of another Juror, Mr. D. Wyatt, are even more emphatic. He says:—"A piece taken at random from the stall of Jennens and Betteridge was placed beside the Prussian. The superiority of the former was incontestible. The Birmingham *black* turned that of the Prussian *brown*. The Birmingham hand-polish was clean and smooth to the touch, the Prussian was greasy-looking with varnish and undulating under the hand; in fact it appeared quite coarse by contrast with the English."

Many of those who, in early life, were decorators of papier mâché, have since become artists in the truest sense of the word, and produced pictures which are valued and coveted by collectors. Not a few, also, have turned their attention to painting on glass, several of the best workmen at Messrs. Hardman's having received their artistic education at Messrs. Jennens and Betteridge.

Manufacturers, in the trade, acknowledge the advantage of the Local Schools of Art as auxiliaries in the training of their decorative artists and apprentices.

In the manufacture of papier mâché articles from pulp, it it is estimated that about 300 tons of the raw material are consumed annually, amounting at £25 per ton to £7,500, and the manufactured products being about £1,000 a year. For the production of the grey spongy paper from which the best goods are made, the Farnworth Mills, near Manchester, are the most celebrated. The demand, however, for best goods has materially decreased, and consequently limited that for this kind of paper. The pulp material, although the articles made from it are inferior in appearance and more brittle in substance, is cheaper than the paper; and, consequently, secures the preference for commercial sale and general use.

Upwards of one-half the labour in this manufacture, it is estimated, is done by females, whose hands seem peculiarly fitted to give the brilliant concluding finish to the surface of the articles. Best "handers" realise from 12*s*. to 16*s*. Women employed in other operations as "blackers," &c., from 10*s*. to 12*s*., and girls 6*s*. per week. Decorative artists or painters of ornament receive from 30*s*. to 50*s*. per week, and superior hands employed on special work still higher wages.

It is calculated that in the papier mâché and japan trade about 1,000 hands are now employed. The numbers in 1861 were 428 males and 465 females. There are no means of arriving at an exact estimate of the numbers employed in papier mâché alone. There are in Birmingham forty-five manufacturers of japanned iron goods, fifteen of whom are also manufacturers of papier mâché.

In the production of what may be termed legitimate articles of papier mâché, such as trays, &c., the trade is not increasing; but there is no falling-off in the demand for large articles of furniture and chairs of combined papier mâché and wood. Large orders for panels for steamboat cabins have also recently been executed, the Birmingham makers having secured the order for decorating the cabins of one of the French Emperor's yachts in competition with French manufacturers.

The tendency to over-elaboration of ornament, fostered by the production of goods for foreign markets has, there can be little doubt, operated in checking the home demand, since purchasers are naturally shy of articles the majority of which, especially in the larger and more elaborate examples, are produced in a depraved taste and vicious style, regardless alike of the material out of which they are made and the purpose for which they are intended. The execution of the ornamentation, so far as manipulation is concerned, is, in the best examples, perfect. The flower-painting is admirable, and the copies of pictures, where introduced, have frequently been rendered with no mean artistic skill; but all such work is inappropriately applied to the decoration of such a material. The same may be said of the profuse use of pearl-work. Pearl flowers are simply an error, as are also those so beautifully coloured and delicately shaped in all their relief, on a horizontal surface, destined to be covered with the paraphernalia of the tea-table. For table tops, &c., conventional ornamentation, in which the design is so drawn as to suggest the idea of *inlaid* ornament, is the most correct in taste. It is only just to the leading papier mâché manufacturers to add that they fully understand the errors of the style generally preferred; but so long as the popular tendency is in favour of ornamentation in which show and glitter preponderate, and articles decorated in accordance with true principles are only selected by buyers of educated taste, it is too much to expect that producers should deliberately shut themselves out of the more extended and profitable market.

BLOCK PAPER AND ITS USES.

By J. B. GAUSBY.

The manufacture of writing and printing paper is not largely carried on in Birmingham, and the principal mill for brown paper has recently been removed to a fitter locality in the neighbourhood. But, although the manufacture of paper in its ordinary form is not one of the important trades of the town, the articles of which paper forms the groundwork are very numerous, and their manufacture gives employment to a considerable number of hands. Some of these branches of manufacture simply work-up ordinary paper and pasteboard, but others require an article possessing altogether different qualities. The manufacture of this kind of paper, and of articles made from it, may be looked upon as more especially peculiar to this locality. In the manufacture of this special paper the whole of the improvements introduced in ordinary paper-making for producing continuous sheets, &c., are useless, and the old-fashioned hand-tools are still used. For the purposes of the japanners, sheets of paper used to be pasted together into the form of tray blanks, panels, &c.—a laborious and expensive operation, rendered still more costly by the duty paid on the paper employed.

About twenty-five years since, Mr. Brindley took out a patent for making these articles from pulp, without the intermediate process of making it into sheets of paper. This pulp is made from rags prepared, washed, and ground in the ordinary manner, and discharged into a vat as was the custom under the old system of paper making by hand. The workshops containing these vats are fitted with two sets of presses, one set placed near the vats and fitted with a table having a trough round its outer edge. Above this table a screw is fitted into a cross piece of the framework, and is worked by an arrangement of levers. The other presses are simple screw presses of considerable size and power.

The workman is supplied with a mould, which is simply a piece of copper wire web, fitted and stretched over a framework of wood—a shallow frame called a deckle, which fits on the edge of the mould, and which, when fixed, forms the mould into a shallow tray. The large screw-press being raised, and a square of felt laid on the block which forms the bed of the press, the workman dips the mould and deckle into the vat full of pulp, and lifting it out horizontally shakes the pulp for the double object of equalising the thickness and felting the fibres of the pulp together. He then allows it to drain slightly, removes the deckle, and transfers the wet sheet of newly-formed paper to the square of felt on the bed of the press. He repeats this till he has accumulated a sufficient number of sheets to form, when pressed, a piece of the thickness he requires, and then places another square of felt on the top of them. These operations are repeated till the press is full.

The press is then put in action, and the water, to a great extent, squeezed out of the wet material, the layers placed between the pieces of felt being thus united so as to form one thick sheet of paper.

When a very thick sheet is required, a deckle with a very deep frame or moveable edge is employed, which is placed on the table-press and then filled with pulp, on which another frame of wire of the same description as the deckle is placed, this frame just loosely fitting into the outer rim. The screw then exerts a gradual pressure, and a considerable portion of the water flows away by means of the gutter round the press-table. These sheets are then placed, several together, between felts, in the same manner as the thinner sheets, and all the water possible pressed out. They are then taken to a hot room and dried thoroughly, if intended for any kind of use, as flat sheets. If intended for trays, bowls, or other articles having any but a flat surface another operation, that of moulding, has to be performed at this stage of the manufacture.

For moulding the wet sheets into shape iron moulds are employed, having the required pattern or shape on them in relief, and not sunk as in ordinary dies. The workman having oiled the mould, places on it a sheet of the paper as it leaves the last press in the pulp room. This he presses firmly with his hand over the mould, taking care that the thickness is regular, and every part well and closely covered. On this he places a sheet of iron, stamped to the form of the solid mould, and on this he places another sheet of the paper with the same precautions, this process being repeated four or five times. When a sufficient number of moulds are arranged to fill a press they are placed on the table of the press, and a very gradual pressure exerted, the power being slowly increased and continued from three to four hours.

By this time the pulp has been squeezed so dry and has become so firm as to retain its shape with the assistance of the iron stamped moulds placed between each sheet. Each mould is then taken in its turn and placed in the drying room. Thus far the process is the same in all cases, and the appearance of both sheets and moulded forms is rough and not unlike thick pieces of whitey-brown paper.

In making the pulp, materials of different qualities have been used, and the different qualities of paper boards produced are now applied to the purposes for which they are intended.

Those for "button boards," as they are technically called, are rolled by a pair of powerful rolls of the ordinary construction, and then cut into round discs of different sizes, called button blanks, which are used for filling up and giving firmness and solidity to Florentine buttons.

Before the abolition of the paper duty these button boards were subject to the payment and all the Excise regulations of stamps, notwithstanding that the purposes to which they were applied were in no way like those for which ordinary paper was employed. For some time, however, before the abolition of the duty, it was evaded by cutting the sheets into blanks at the paper-mill, the Government allowing them to be sold in that form free of duty. This naturally led to the transference of what was one of the operations of a button manufactory to the paper makers, as a few paper makers had thus to cut blanks for many button makers; this department of their business so increased as to lead to the employment of presses worked by steam, the cost being so greatly reduced by this means that blanks were sold at much less than the boards duty paid would have cost, had the button makers cut the blanks themselves.

The other sheets, after having been well rolled, are taken with the moulded articles and dipped in linseed oil, the workman taking care that just enough is absorbed to penetrate to every part, and no more, as an excess would spoil the goods.

After dipping, they are placed in an ordinary japanning stove, and dried. In the process of drying, a thick pungent vapour is given off abundantly; but, on weighing the articles after leaving the stove, it is found that they have lost nothing by the drying, the oxygen taken up by the oil compensating for all the vapour given off. The effect of the oil is to make the material hard and firm, and exceedingly strong. In times, when linseed oil has been dear, many experiments have been tried to find a substitute; but, though substances have been used which give the required hardness and strength at a cheaper first cost, it has always been found that, owing to the non-absorption of oxygen in drying, the loss of weight counterbalances any advantage derivable from their use. The articles, after being dressed smooth, are then ready for the operations of cabinet-makers, japanners, and others.

The freedom of this material from all liability to warp or split has of late brought it into favour for panels for railway and other carriages; and, for those purposes, sheets, so large as 8 feet 6 by 3 feet 2, are frequently made. The uses to which the material in this state is applied, are exceedingly numerous; but are so connected with other manufactures, that any description would be more appropriately introduced into an account of their operations. The manufacture, however, of imitation jet ornaments, to which the process of Messrs. Davenport and Cole has given a large development, seems to have been actually called into existence by the peculiar properties of this material, and the ease with which it can be worked.

In this manufacture the process is exactly as has been described, except that the material is made in pieces that would be more appropiately called blocks than sheets, in the preparation of which the greatest care as to material and manipulation is required. These blocks are afterwards sawn into small boards, and these boards form the raw material of the jet ornaments. These boards are converted into the finished ornaments by means of grinding wheels, of various shaped edges and material, which cut the pieces into any form or pattern into which real jet is capable of being made, the blacking and polishing being so well executed as to make the appearance exceedingly like the real article.

One instance of economising waste worth notice in this manufacture, is that the dust collected from the process of cutting into form by the wheels is collected and made plastic by mixing with a cement, and from this composition are formed brooches and other articles where the pattern is a bow, or any other involved design, thus not only effecting a large saving of material but making, with the greatest ease and rapidity, articles which when cut out of the solid took a long time and required considerable skill.

ROPE-MAKING: HEMP AND TWINE.

By JOHN TURNER WRIGHT.

THOUGH Birmingham cannot claim to be either the exclusive or the principal seat of the manufacture of hemp and wire ropes, yet this industry has of late years attained such an important position in the town as to deserve, and even to require, a chapter in the present volume. To the ordinary branches of the trade it is impossible to assign any special locality; twine-making, at all events, is carried on throughout the kingdom—every considerable town having its spinning-walks, intended chiefly to supply local wants. It is, however, only in comparatively few places that the manufacture is established on an extensive scale, for the production of ropes for general use, or for exportation; and the places are still fewer in which the full assistance of costly machinery, and the resources of steam-power, are called into operation. The largest and most important "roperies," properly so called, are to be found in Liverpool; in the various shipping towns on the Tyne, Wear, and Tees; in London; at some of the Royal Dockyards; in a few of the Scotch ports; and lastly, though not least, in Birmingham. It is probable, indeed, that our own town affords—at the Universe Works, Garrison Street—the most favourable opportunity of witnessing the entire processes of rope and twine making under one roof; in their various branches of hand-made hemp rope, of twine spinning and hemp-rope making by machinery, and of the manufacture of wire-rope; while one branch, that of hemp and wire rope combined, is exclusively confined to Birmingham, under the patent of Messrs. J. and E. Wright.

Though the manufacture of wire rope is of comparatively recent introduction into Birmingham, it has already taken strong root here; and this town bids fair ultimately to become one of the principal, if not, indeed, the chief seat of the manufacture, owing partly to its central position, and the consequent facilities of carriage; but mainly to the fact that Birmingham possesses almost a monopoly of wire-drawing, and therefore enjoys peculiar advantages for the production of articles of which wire forms an important constituent part. The justice of this anticipation is proved by the circumstance that Birmingham-made wire-rope has already established itself in the market as a formidable competitor with the production of other districts; and the rapid increase of the trade warrants the belief that in this branch of industry the Metropolis of the Midlands has an important future before it.

To trace the history of rope-making is out of the question —the origin of the art is lost in remote antiquity. From the earliest ages every nation has known how to make ropes of some kind or other; and for this purpose all kinds of materials have from time to time been employed—from the coarsest and roughest grass, rudely plaited or twisted by manual labour into strands, up to the choicest Russian, Italian, and Manilla hemp, spun first into yarn by elaborate machinery, and then laid and formed into the finest twine or the stoutest cables, with a degree of care and skill unsurpassed by the most highly organised branches of manufacturing industry. But though of an antiquity reaching back almost, if not actually, to the earliest ages of man, it is only within the last century that rope-making has received much attention from mechanical inventors. Even now, the process which has existed without material change for hundreds of years may still be seen in operation in our open rope-yards and spinning-walks—the primitive wheel, the workman with a bundle of hemp strung round his waist, and the slow, laborious, and imperfect operation of laying and twisting the strands by manual labour.

Looking back upon the unscientific methods exclusively in use until about eighty-four years ago (when the first rope-making machinery was devised) it is really wonderful to think how our ancestors could have contented themselves with the slow processes they employed, and the unsatisfactory results they obtained. The spinning of hemp and flax into yarn was done entirely by hand and in the open air, and the manufacture of ropes was conducted in an equally unscientific manner; the yarns, supported at intervals upon "stake heads," were stretched the full length of the rope-walk, then divided into the number required—they were slowly twisted together into strands, and afterwards the strands thus produced were twisted into ropes; the ropes, when cables had to be made, being similarly twisted, until the necessary strength and thickness were attained.

It was possible in this way to make tolerably perfect short and small ropes, but at the best the large ropes thus made were very unsatisfactory, because the strands were unevenly formed, and when arranged in ropes they were subjected to great differences of tension according to their position, and thus, notwithstanding the utmost care on the part of the workman, the rope was always of unequal strength. Whatever the materials of which it is composed, a well-made rope should present a perfectly even external surface, and the strands should be so arranged as to bear a uniform strain throughout the length and thickness of the rope. These essentials, together with the economy of labour, greater speed of production, and the diminution of cost, are the objects which have been aimed at by the several inventors who have applied themselves to the construction of rope-making machinery. In the main, these objects have been almost perfectly attained by successive inventors; but within the last half century the improvements in machinery have been so rapid, and the patents taken out so numerous, that it is utterly impossible to assign to any one, or to any certain number of inventors, the credit of having brought rope-making machinery to its existing state of perfection—indeed, every year instances some change in the machinery—and it often happens that an alteration of what is seemingly mere detail, effects an improvement which is of the greatest value to practical men, but is incapable of explanation to others.

It would be a mere dry record of names and dates to recount the successive patents taken out for hemp rope-making machinery. The series virtually began in 1792, with Cartwright's famous "Cordelier;" and has continued until now—the most notable inventions having been those of Chapman, of Newcastle; Belfour, of Elsineur; Captain Huddart; Carr, of Sheffield; Fothergill and Crawhall, of Southwick; Lang, of Greenock; Stewart, of Glasgow; Horner, of Belfast; Norvell, of Newcastle; and Swallow, and Garnock, of Liverpool. The patentees, thus hastily enumerated, (and others whom it is needless to mention,) bring the invention of rope-making machinery down from its beginning in 1792, to the present day. The list includes machines for spinning yarns, (due chiefly to Mr. Lang); for twisting yarn into strands, the credit of which originally belongs to Captain

Huddart; travelling machines, running on tramways along the rope-yard, and "closing" the strands into ropes, (due to Chapman;) hackling machines, (invented by Horner); and, finally, "endless" rope-making machines, (the invention of Mr. Norvell,) which make strands and ropes at the same time without a rope-yard. With this brief introductory sketch, I proceed to describe the process of rope-making by machinery, under its main divisions of hemp and wire rope, the machinery in each case being understood to be driven by steam power.

MANUFACTURE OF HEMP ROPE.

This consists of four processes: (1) Preparing the hemp for spinning; (2) spinning the hemp into yarn; (3) twisting the yarn into strands; and (4) forming the strands into a rope.

The hemp is imported ready "scutched," *i.e.*, cleansed from dirt and other imperfections. When received, the first thing done is to sort it from the bales, and to cut it into lengths of from thirty inches to three feet—it being impossible to produce yarn fine enough for general purposes if the hemp were worked at its full length, from seven to eight feet. The first process is that of "hackling," that is, to separate the fibres from each other, and to arrange them parallel for spinning. This is done by throwing the ends of the fibres lightly on the points of sharp steel pins, fixed in rows on a board or "stock," and technically called a "heckle." The pins are nine or ten inches long, about three-eighths of an inch in diameter at the lower end, and gradually tapering to a sharp point. The operator stands in front of the heckle, and throws the loose ends of the fibre on the pins, repeating the operation until the fibres are perfectly parallel and thoroughly disengaged from each other.

The prepared hemp is next submitted to the action of a machine called a "lapper," the object of which is to soften it, and induce still greater regularity of arrangement and perfect separation. The lapper consists of a table, having on each side a wooden ledge, six inches high, eight or nine inches wide, and three or four feet long, forming a sort of channel. At the extremity are placed two fixed rollers, each six inches in diameter, one above the other; the lower one receiving its motion from a central spindle, by means of a belt and pulley; the upper one pressing against its fellow by its own weight. The hemp is regulated in its passage up the above described channel, by a workman standing behind the machine. Immediately in front of the fixed rollers is placed a circular arrangement of heckles, having a downward motion, thus leading the fibre from the fixed rollers to the under-side of the heckle frame. A case of sheet iron is so arranged as to form more than a half-circle over the heckle frame, and to come within half-an-inch of the pins, thus keeping the fibres on the cylinder. Between each row of pins, a small bar is placed, working with an eccentric motion, and causing the bars, between the heckle stocks or "fallers," to recede as the circular arrangement, or barrel, of pins passes the feed rollers, and gradually advancing towards the point of the heckle pins as they come up on the other side, thus forcing the fibres off the ends of the pins. At this point, the fibres are being "lapped" or wound on to a large drum, six feet diameter, travelling with great velocity, and full of heckle pins, arranged in longitudinal rows. When a "lap," of between six and seven pounds weight, is wound or lapped on the cylinder, the belt is thrown off, and the cylinder stopped by means of a powerful break. The workman then takes a round steel bar, inserts it between the surface of the cylinder and the fibres, bursts the latter asunder, and draws them clear of the heckle pins. The "lap" of hemp is, by this time, about nineteen feet long, and is ready for the next process—that of "spreading" and "drawing."

The object of this process is to convert the "lap," of prepared fibre into a continuous "sliver." This is done by placing the lap on a travelling sheet, supported on a table, and having a uniformly progressive motion imparted to it by means of rollers arranged at each end. At the upper end of this travelling sheet are placed two feed rollers, called, for the sake of distinction, "retaining" rollers, and moving in opposite directions. The fibres are guided from the travelling sheet up to the retaining rollers by means of polished iron guides. After passing through these rollers the fibres are once more penetrated by heckle pins, arranged on bars or "fallers" which have a continuously progressive motion. There are two kinds of mechanism for the production of this motion, known respectively as the "sheet gill" and the "screw gill;" the former, the older method, is now entirely superseded by the latter, which may be described as follows:—The heckle teeth are placed on bars or "fallers," supported at the ends by guide bars, fastened to the inside of sockets in which revolve endless screws. Two of these screws are placed at each side of the machine, one above the other, and working in opposite directions. The upper pair of screws carry forward the heckle bars or "fallers" from the retaining to the drawing rollers, at which point they drop clear of the hemp fibres on to fixed bars placed below, where they are received into the lower set of screws. Being thus clear of the fibres they are conveyed underneath the upper set of bars or "fallers" back to the retaining rollers. The heckle teeth attached to the "fallers" thus always project upwards, and are presented perpendicularly to the hemp at every stage of their movement. After passing over the above described arrangement of heckle pins, and through the drawing rollers, the fibres, in the form of a "sliver" or flat ribbon, are delivered by means of another pair of rollers into a tin can placed at the end of the machine. An ingenious arrangement connected with this process remains to be mentioned, namely, the registration of the length of the "slivers." This is effected in the following manner. At the extremity of the axis of the lower drawing roller is placed a small endless screw, working into a worm wheel; on the axis of this wheel is placed another endless screw, driving a second wheel; in the rim of the latter is inserted a pin or stud, which at each revolution of the wheel communicates with a small bell by means of a spring, thus giving notice to the attendant that a "sliver" is complete.

From this machine the "slivers" go to another nearly similar in all its parts, with the exception that, immediately under the rollers, a polished steel plate is arranged instead of the spreading tables; and a number of "slivers" are put in together. When they leave the machine, the "slivers" are found to be characterised by evenness, fineness, and regularity. This is known as the "second drawing." Another machine next performs the "third drawing," exactly similar in principle, and then the "slivers" are ready to be spun into yarn.

The process which the hemp undergoes at the spinning frame is analogous to that of the preparing machinery in the first part of its treatment. It first passes over a polished curved plate to the retaining rollers, and thence to the "fallers" or heckle bars. It then enters the front or delivery roller, at which point "drawing" or reducing the hemp comes to an end, the "sliver" being now of the size required for spinning. Over the part of the delivery roller the "sliver" passes on to a curved, polished iron plate, with angular groove to receive the thread, on which presses a rubber lined with thick flannel, to give it smoothness. Immediately beneath the grooved plate is the top of the "fly," through an opening in which the thread passes on to a bobbin placed within the fly. The bobbin rests on a drag-plate, and thus, when motion is given to the fly, the bobbin revolves with it. Upon the drag presses a spring to take up the thread as it is being delivered from the roller, and at the same time the twist in the thread runs up through the top of the fly to the grooved plate; here the rubber arrests the twist, and forms the thread in its finished state. Thus the delivery, twisting, and taking-up proceed continuously until the bobbin is full. At the neck of the fly there is an ingenious arrangement for loosing the fly, and allowing the bobbin to be taken off. This is a spring catch which flies open when touched by the operator, and allows the fly to come forward, and the full bobbin to be taken off and replaced by the empty one. The yarn is now finished, ready for tarring, to be made into ropes.

Some idea of the power and speed of the machinery may be gathered from the fact that at Messrs. Wright's factory at Millwall, during the manufacture of the yarn for the Atlantic Telegraph Cable just laid, the preparing and spinning machines (200 spindles) turned-out regularly in the twenty-four hours the almost incredible quantity of 3,053,020 yards of finished yarn—every process of preparing, heckling, drawing, and spinning being performed by machinery, in the above-mentioned time. The machinery, it may be mentioned, is driven by engines of 80 horse-power.

We have described the process of spinning at some length, because it has only lately been brought to its present advanced state. The actual formation of the yarn into ropes may be more briefly dismissed. This may be effected by Norvell's endless machines, of which no idea can be conveyed without diagrams; or by the modification of Captain Huddart's machine, which is that most commonly in use. The bobbins of yarn are placed in a frame—as many as forty or fifty at a time—and the ends of all the yarns are passed through an equal number of small holes in a plate, and confined in one close group, which is slightly compressed by passing through a tube, and then wound on a reel. The mechanism between the plate and the reel rotates on a horizontal axis, thereby imparting a regular twist to the assemblage of yarns. The free rotation of the bobbins, the arrangement of the holes in the plate, the position of the tube, and the velocity of revolution, all combine to produce a strand of any desired hardness of twist, without undue strain upon any of the yarns. The strand thus produced is a smooth uniform piece of cordage, varying in thickness according to the number of bobbins, which depends upon the thickness of rope to be made. The next process is to form or twist the strands into a rope. For this purpose another machine is used, travelling up and down a tramway. The required number of strands are attached to separate but continuous hooks in the front of the machine, and as the carriage travels down the tramway, the outer strands are twisted in contrary directions round the central one. By a simple but ingenious arrangement the twist given to the strands is regulated at pleasure, and they are laid with the greatest regularity at any desired angle. In this manner the pressure is so managed as to give the fullest elasticity to the rope, and all parts of it are made to bear equally in the working strain.

MATERIALS AND USES OF HEMP ROPES.

Hemp ropes are made of Russian, Italian, or Manilla hemp; but since the Crimean war, which interrupted the Russian trade, the first-named kind has been practically disused. Its place has been chiefly supplied by Manilla (of which the yarn covering for the Atlantic Telegraph cable was made). Russian hemp is, however, still used, chiefly for twine, but also, in some instances, for ropes. Its price averages about £30 per ton. Italian hemp, though of excellent quality, is less used, on account of its high price, about £36 per ton. Manilla, which is most generally used for ropes, answers every practical purpose; its average price is about £28 per ton. Hemp ropes are largely used for the rigging of ships (though for this purpose, especially in regard to standing rigging, they are giving place to wire, or to combined wire and hemp,) for ship cables, pit ropes, and for general purposes. Hemp rope also keeps its hold on the foreign and colonial markets, although the latter are beginning to take wire rope in larger quantities than heretofore. Alterations of tariffs have had no perceptible effect upon the manufacture, the increase in the exports of twine and cordage having been steadily progressive since 1851, when the value exported was £240,727, up to 1865 (the latest official return), when the value exported was £416,279. The following is a statement of the imports and exports for the year 1865:—

	Cwts.	*Value.*
Hemp (undressed) imported	1,002,980	£1,599,633
Hemp re-exported	152,055	252,320
Cordage and twine exported	169,371	416,279

THE MANUFACTURE OF WIRE ROPE.

Wire ropes appear to have been first used in Germany, in the mines of the Hartz Mountains, where they were known to be in use as far back as 1832. The invention in England is claimed by Mr. Andrew Smith, a London engineer, who made a piece of wire rope in 1829, and in 1835 patented his invention, after which date he took out several other patents for the same manufacture. Wire rope appears to have been first made at Great Grimsby; but in 1840 Mr. Newall, of Dundee, took out a patent for a greatly improved process, and fixed himself at Gateshead, since when the manufacture has been extensively carried on in the district of the Tyne and Wear. At first, wire rope was rudely made, wholly or partly by hand, and was then open to the objections alleged against the old-fashioned hand-made hemp rope. Now, however, wire rope is made exclusively by machinery—either by Newall's patent, or Archibald Smith's patent, or modifications of these. The wire is first wound upon a triangular frame, called a reel. From this it is transferred, by winding, to bobbins similar to those used in ordinary yarn-spinning machinery. The bobbins are mounted in frames set on the periphery of a larger frame, like a cage. The cage revolves round an axis, on the bottom of which is a fixed spur-wheel; and the lower end of the vertical axis of each bobbin frame carries a spur-wheel gearing into this. There is thus obtained a sort of "sun and planet" motion, the cage carrying the bobbin round the central axis, and each bobbin frame revolving also on its own axis. The wires, in their progress from the bobbins, pass through holes in the top of the central axis, and are there united to form the strand. Another machine, of somewhat similar construction, afterwards forms the strands into a rope, five strands being laid round one (which passes up a hollow central spindle), and the required twist being given by passing the strands through a kind of draw plate fixed at the upper end of the machine. This is the principle of Newall's machine. Another machine (Archibald Smith's), now coming much into use, differs altogether from this. Instead of placing the bobbins on a circle, and causing them to revolve round the axis of the machine, this arrangement places them horizontally, seven deep, in the centre of a machine which revolves round them, and carrying their separate wires and core to the laying (or draw) plate, closes the wires into a strand, or the strands into a rope. This machine allows of a speed four or five times higher than Newall's machine; from 1,000 to 1,500 yards may be made by it in an hour.

Flat wire ropes are made by taking circular ropes, laying them side by side in a stout frame, and then stitching them with soft wire forced diagonally between the strands of each rope. This is done so perfectly that it is difficult to tell where the spinning or twisting ends and the stitching begins.

The materials used for wire rope consist chiefly of the best charcoal iron, or of steel; but the latter is most used. Sometimes copper is employed for special purposes, such as lightning conductors. For ordinary ropes, however, it is found that iron is adequate to all purposes, being strong, light, easily worked, capable of the heaviest strain, and cheaper than steel. Sometimes the wire is galvanised, and sometimes tarred in the same manner as hemp rope.

Wire rope is used for almost all purposes to which hemp rope can be applied; but it is principally employed for the standing rigging of ships, for hauling and winding in collieries, bridge building, and for agricultural and railway purposes. For a long time after its introduction, colliery managers and others were rather afraid of the novelty; but by degrees the wire rope came into favour, and now—especially in the north of England—it is displacing hempen ropes for colliery purposes. Nor is this to be wondered at when the comparative strength and durability of the two kinds are taken into account. The weight, for example, is greatly in favour of wire as against hemp; a hempen rope of 150 fathoms in length weighs three-fifths of its working load, while a wire rope of the same length weighs only one-third of its working load. To put this in another way, a round hempen rope of twelve inches circumference weighs thirty-three pounds per fathom, while a wire rope four and three-quarter inches in circumference though quite as strong weighs only eighteen pounds per fathom. The test of the breaking strain is equally conclusive. A hempen rope, weighing ten-and-a-half pounds per fathom, breaks at a strain of nine tons five cwt.; while a wire rope of the same weight is capable of bearing a strain of fifteen tons six cwt. before breaking. Then, again, wire ropes are cheaper than those made of hemp, so that every way the advantage rests with the wire. It costs less, weighs less, endures nearly twice the breaking strain, does more work, runs at higher speed with less engine power, lasts longer, and finally—a great point in collieries—is much less liable to be affected by damp. Now that wire ropes have become articles of local manufacture, it may be anticipated that the use of them will become as popular in the Staffordshire and Worcestershire colliery districts as it is already in the coal fields of the North of England.

HEMP AND WIRE-ROPE COMBINED.

Within the last ten years, another kind of rope has come largely into use—the combination of hemp and wire (patented by Messrs. J. and E. Wright, Birmingham and London). The plan is thus described in the specification :—" We take a wire of iron, or other metal or alloy, and coil around the said wire, hemp, or other fibrous substance, the said hemp or other fibrous substance having been previously twisted into a thread, and covering the wire and lying thereon in a helical or cork-screw direction. The threads thus made, we combine into strands, and the strands into rope, cord, lines, twines, and mill-bandings, in the usual manner. We do not limit ourselves to the use of any particular number of hemp or fibrous threads for covering the wire, nor to the use of a single wire, as two or more wires may be enveloped in the same covering of hemp or fibrous threads." Ropes made on this patent, possess greater pliability than wire ropes, and also greater strength in proportion to weight. The following table exhibits the comparative strength of wire rope, hemp rope, and rope composed of hemp and wire combined :—

Weight per fathom.	Breaking Strain of Wire Rope at the same weight per fathom.		Breaking Strain of Hemp Rope at the same weight per fathom.		Breaking Strain of Wire and Hemp.	
Tarred.	Ungalvanized.					
10½ lbs.	15 tons	6 cwt.	9 tons	5 cwt.	21 tons	0 cwt.
8½	13	10	8	0	19	10
7	10	15	6	10	15	10
5⅓	7	8	5	5	12	5
4⅓	7	0	4	10	10	0
2⅓	3	5	2	10	8	0
1¾	2	0	1	10	4	0

In reference to the introduction of wire rope-making into Birmingham, it may be allowable to quote the following remarks from the *Birmingham Daily Post* of March 29, 1866 :—

> "The introduction of wire rope-making is due to the energy and spirit of Messrs. John and Edwin Wright, of the Universe Works, Garrison-street, (and Millwall, London,) who were, some years ago, the first to introduce into this district the making of hempen ropes and twine by machinery. To this branch of their trade they have now added the manufacture of wire ropes; and when

we come to think of it, it is odd that this addition should not have been made long ago—or rather, that the making of wire ropes should not have been indigenous to Birmingham, instead of wandering away northwards, and establishing itself as a specialty of Tyneside industry. We say it is odd, from the fact that wire-drawing is peculiarly a Birmingham trade. We are, in fact, the great wire-drawers of England, and to a great extent, of Europe and America. The wire of the last Atlantic telegraph was made in Birmingham. The wire of which the new telegraph will be composed, is being made here; in fact, except the actual making up, the cable will be wholly of Birmingham production—the very patent under which it is being constructed being the property of the Messrs. Wright, and the Telegraph Construction Company being their licensees. So with these wire ropes—though the manufacture is carried on elsewhere, the materials are made in Birmingham, and have to be sent hence to be made up; and thus, when the manufactured article comes back into this district, as it does largely, the consumer has to pay for the double carriage, as well as for the material and the skill expended upon it. Now, however, thanks to the Messrs. Wright, the anomaly is corrected; and though we don't want to injure our friends in the north of England, it may turn out that Birmingham will eventually absorb an important branch of manufacture which ought always to have been, but is now for the first time, reckoned amongst her industries."

TRADES ALLIED WITH ROPE MAKING.

There are numerous branches of trade which, at all events in this district, have come to be allied with rope making. Among these may be mentioned the preparation of hemp and flax for railway purposes (an important branch of manufacture, involving several ingenious processes;) the making of felt, for boiler covers and roofing; the manufacture of rick and waggon covers, and of flexible waterproof oil sheets for railway trucks; mat making, carriage rug making, and others too numerous to be mentioned.

PERSONS EMPLOYED, AND CONDITIONS OF LABOUR.

According to the census of 1861, the total number of persons employed in Birmingham in rope and twine making was 423—namely, 67 females and 356 males. Of these 9 females and 64 males were of the age of 10 years and under. Since the date mentioned this number has been considerably increased; but there are no means of ascertaining the number actually employed at present. The introduction of machinery has had the effect of placing the women and children employed in the trade under the operation of the Factory Acts, limiting the labour of women and young persons under eighteen to ten hours per day, and of children under thirteen to half-time. The women are chiefly employed in connection with heckling and spinning machinery. Their wages range from 6*s*. to 10*s*.

per week, unskilled labour being sufficient for this branch. As regards the men, good workmen will earn from 30*s*. to 40*s*. per week at rope making, and from 25*s*. to 35*s*. per week at twine making. Being carried on in the open air, under exposed sheds, and in lofty well-ventilated buildings, the trade is usually healthy, especially in the large roperies arranged on modern principles.

WIRE DRAWING AND STEEL WIRE, AND ITS USES.

By CHARLES LEAN.

Very few of the trades for which Birmingham is now so famous will exhibit more astonishing results than the Wire trade, particularly the manufacture of *Steel* wire. It is not easy to detail its early history, or to condense into an acceptable form the numerous features it has assumed in modern times, so varied are the experiences of each manufacturer. We will, therefore, endeavour to give a hasty sketch of the *introduction* of this trade, and must then confine ourselves to the facts obtained from one firm, (Messrs. Webster and Horsefall, who have lately been so much before the public in connection with the manufacture of the Homogeneous metal for the Atlantic Cable,) as a sample of the astonishing growth and present extent of the *Steel* wire trade more especially.

Iron wire was first made in Germany, about the year 1450, but the manufacture was something very different to the wire-drawing of the present day. Rolls and draw-plates were of course unknown then, and, instead of the speedy and effective processes which now produce the highly-finished article, our forefathers had to endure a laborious occupation and be satisfied at last with a very unsightly production. All their metal was gradually reduced to a manageable size by some sort of original tilt-hammer, and finally brought down to the various gauges (if indeed it could be gauged) of finished wire by patient hand-hammering. Our imaginations will best depict what sort of wire it was, and the amount of rotundity and general uniformity it was likely to possess. The use of the draw-plate first took the place of this slow and unsatisfactory method, about the year 1560, and but little alteration was made in the general manipulation after this till comparatively recent times. Wire-drawing seems to have become an English trade about the year 1670, when we hear of it first in the Forest of Dean district and Tintern Abbey, and soon afterwards at Stourbridge and *Penns* (near Sutton), at which latter place Mr. John Webster, the head of the old house of Webster and Son, converted an Iron Forge into a Wire Mill, in 1720. Steel wire came into use not long after. It would be difficult to say much about the supply of Steel wire in the early part of this century, nor is it necessary to go so far back to show the wonderful growth of the trade. We may say that 40 years ago Mr. Webster's annual make was about 50 tons, and this would represent a very large proportion of the total manufacture in England. In 1849, or 16 years ago, the total supply of this firm was 90 tons, showing only a very gradual increase; and it is only during the last 10 or 12 years that the extended application of steel wire necessitated the wholesale manufacture of our day, and produced the total results which the same firm alone are able to supply; their consumption for the past year having exceeded 2000 tons.

One of the first improvements in the mode of manufacture, which would also greatly lessen the cost and trouble of production, was the change from tilting to rolling, which took place about the commencement of this century; and at the same time, or perhaps a little earlier, the use of winding blocks or drums, driven by powerful machinery, assisted materially in increasing the supply, and altogether altering and beautifying the appearance of the finished article. Not a century ago a *horse* was employed by a firm in this town to draw the wire through the plates by means of a similar apparatus to that still used by brick-makers and others for grinding clay, &c., and the men had to make the best looking bundles they could by coiling the wire round and round in their hands. Early in this century, also, the open ovens, in which the annealing or softening of the wire used to be accomplished, were exchanged for the closed pots now in general use. These, however, are chiefly improvements in production; we have still to notice one or two alterations in the mode of manufacture, affecting the quality of the article, which have so largely assisted in extending its adaptability to almost every branch of trade. One of the first things which seemed to compel a radical change in the manipulation of steel wire was the great demand for it for musical purposes, particularly for Piano-fortes. These instruments were first made in Dresden in 1717, and in London in 1766, and the wire made for them was chiefly from Nuremberg and Berlin up to the breaking out of the European war.

The difficulty of procuring it in sufficient quantities during this period, as well as its unsatisfactory quality, caused many attempts to be made to manufacture it in this country, but without much success, until the year 1824, when the late Mr. Joseph Webster, of Penns, succeeded in producing a music wire which fully answered the purpose. His success was entirely attributable to his discovery that the use of certain chemical fluxes in refining his metal were of the greatest service in producing a pure, reliable article. This discovery had the effect of almost closing the Continental music wire trade, and of giving Mr. Webster and "Penns" a world-wide reputation. Such success was of course not allowed to pass unnoticed, and produced a rivalry which very soon gave birth to fresh discoveries and improvements, and very largely extended the field of operations. From the year 1824 to 1845, but little material improvement had been effected, though it was being more and more felt by piano makers that they were not yet obtaining the article they wanted. The "Penns" wire was not hard enough—stretched—did not "come up to pitch" quickly—and would not remain long enough in tune without variation. It was, in fact, absolutely necessary that an article should be produced as hard as glass and as tough as leather, and, in 1854, Mr. Horsfall, after directing the whole of his energies to the subject, succeeded in producing the very article so much sought for. *He* employed a process totally different to any before known, and his mode of operation appeared at first incredible. The usual way of making wire is to *anneal* it repeatedly, making it sufficiently soft for the workman to reduce it to the size required. On the contrary, Mr. Horsfall *hardened* his wire by heating it red hot and plunging it into water, and afterwards, when necessary, just softened the outside by passing it through a bath of melted lead. This was a complete revolution in the trade, but has paved the way for the introduction of steel wire to uses for which it could never have been otherwise available. The same principle, varied slightly, perhaps, to suit particular requirements, and receiving those alterations and improvements which experience would suggest and genius would devise, has carried the trade gradually on to its present variety and importance.

Steel wire is now chiefly used in the manufacture of needles, fish-hooks, springs, music-strings, small tools, umbrella frames, crinolines, and ropes; both for the home and foreign trades. Its application to ropes and cables is of very recent date, and is entirely owing to the success of Mr. Horsfall's invention: *ordinary* steel wire being manifestly useless for the purpose, and absolutely dangerous. As soon as it became known that a steel wire could be produced, which combined all the advantages of *lightness* with *hardness* and extreme *tenacity*, it soon obtained a considerable share of popular favour; and, although it has been introduced within the past seven years, it has already attained a high position in the estimation of consumers, and, as prejudice is more and more overcome, must some day attract still greater attention. The steel wire rope is now used at many collieries; and is highly valued in deep pits especially, where the light *weight* of the rope is of such importance, both in connection with the safety and the economy of the working.

For railway inclines, lifts, and even ships' rigging the same reasons are rapidly bringing it into use. Not the least important of the various mechanical inventions of the present day, which the introduction of a suitable quality of steel wire has materially assisted in perfecting, is the application of steam machinery to agriculture. The late Mr. Fowler has more than once declared "that he owed the success of his plough to the introduction of Webster and Horsfall's steel wire." But the most important use to which this wire has yet been adapted, and the one which is now exciting such universal interest, is the manufacture of submarine telegraph cables. During the past five years large quantities have been used for cables in the Mediteranean; and lately, as is well known, it has formed an important and successful portion of the Atlantic telegraph cable.

The manufacturer of this wire, in its various departments, kept nearly 250 hands employed for eleven months. The total quantity supplied being over 30,000 miles in No. 13, I. W. G. (= ·095.)

Although the foregoing remarks are confined to one firm, it must not be supposed that they are the only manufacturers; or that Birmingham alone possesses any wire mills. We may mention Messrs. Everitt and Sons, Cornforth Brothers, Jenkins, Hill, and Jenkins, Edelston and Williams, John Cornforth, Hibell and Co., &c., as well-known makers of wire. Twenty-five years ago there were only about 90 hands engaged in this trade in Birmingham, now there are nearly 600, besides boys. There are no women or girls employed in the *manufacture* of wire. The average earnings of a good workman, at full time, would perhaps be 35*s.* per week; but there are exceptional cases, when, for some few months together, from 50*s*. to 65*s*. might be made. Out of Birmingham, wire drawing is chiefly carried on at Warrington, Manchester, Halifax, Sheffield, and South Wales.

Wire drawers, as a body, do not take high rank in the social scale, but possess perhaps as many noble exceptions as others, and have progressed with the times as satisfactorily as most. When they are more fully alive to the advantages of temperance and providence, we may hope to see them exhibiting a higher state of happiness, and fulfilling their part in the world as creditably as they are certainly qualified to do.

WIRE WORKING.

By J. B. GAUSBY.

Wire is applied to many uses evident to all who will merely take the trouble to look round their own houses; but as these articles are usually either small or of comparatively small importance, most people have but little idea of the number of workmen employed in their production, or of the extent of the manufacture of these apparently insignificant articles. In the actual process of making most of these articles there is but little to describe that would interest the general public, the whole matter being merely a series of bending to shape, placing in position, and tying with fine soft wire the pieces of wire requisite to form the articles required. But even in some of these instances recent improvements have enabled manufacturers to employ machines to a certain extent, while in others hand labour is entirely superseded. This is especially the case in weaving, twisting netting, chain making, the manufacture of gimp and escutcheon pins, piano-forte key pegs, cotters, and a variety of other articles.

The foundation of many wire articles is woven wire gauze, of different degrees of fineness, and the weaving of this gauze of wire for malt kiln and other drying floors, and of netting of different meshes, is a very large and important branch of the trade. The loom employed is of the simplest construction, all pattern being given to the articles by other means; and in the case of fine gauze or kiln floor web the wires forming the weft are brought together by a sharp blow of the batten of the loom, as close as the thickness of the woof will allow. In wire cloth of a more open mesh considerable skill is required on the part of the workman to keep the weft at regular distances, the regularity being entirely dependent on the correctness of his estimate of the distance, the woof, of course, being regulated by the machinery of the loom. The demand for all these articles is gradually and steadily increasing, and it is with difficulty that the supply of skilled workmen is kept equal to the demand.

In addition to the products of the loom, a kind of wire trellis, of square or diamond-shaped mesh, is much used for many articles, such as fire-guards, &c., which were formerly made by interlacing straight wires by hand, and then tying the intersections with binding wire. This was a slow and tedious method, with the disadvantage after it was done of leaving a rough surface. Machinery, however, has here effected a great improvement, though the actual interlacing of the wire is still done by hand labour. A patent was taken out some time since, for corrugating or indenting the wire used for this purpose by passing it between a pair of rollers, having groves cut on their surfaces corresponding with the wave it was desired to give the wire. These wires were then employed for the production of the lattice, and a given number being arranged on a bench, and kept in place simply by a block of wood placed on their ends, the girl (for the work is usually done by girls) takes another piece of the waved wire and places it at the required angle, alternately, between the wires already laid down, so that between every wire there is an indentation of the wire which crosses them. This is repeated, so that the result is a trellis that requires no tying at the intersections, the whole being well held together by the indentations, each wire holding the one which crosses it in its place.

The absence of the tying wires much improves the appearance, and entirely prevents the roughness that was so objectionable under the old method. The very simplicity of the patent, and its great utility have, however, prevented the patentee from receiving all the benefit he expected, or his ingenuity deserved, as it is infringed continually by such a number of small makers who are too poor to pay the costs of the proceedings necessary to stop the infringement, that the patentee finds it cheaper to let them alone than to incur costs he cannot recover. There is yet another kind of wire fabric that may be noticed while considering this particular branch of the trade; that is, Wire Netting for Fencing, Aviaries, and many such purposes. This "peg lattice," as it is technically called, was, till lately, made entirely by hand, while now the machine-made, though slightly different in the shape of the mesh, bids fair to supersede the hand-made article.

The machine by which the manufacture of this article is accomplished is difficult to describe intelligibly without drawings. The wire is wound on two sets of bobbins, one set much like very large cotton reels which are stationary. The others, which are some three feet long, being fixed perpendicularly in a frame in the machine, which moves the whole series alternately from right to left and the reverse way a distance equal to the hexagon mesh being made; at the same time a rotary motion is imparted to each bobbin individually, which twists the wires two or three times over each other and thus fixes the stitch (if we may use the term) which has just been completed, the wires at the time of this twisting being kept at the requisite distance just above the twist by pegs fixed in a roller, which by its revolution ensures the pegs being in their proper place at each twist. As the netting is made it is rolled off at such a rate as will just keep up the required tension on the wire as it comes from the bobbins.

The machines are so constructed as to make one very wide piece or several narrow ones at the same time, as may be desired. There is a very large quantity of wire chain made, both of iron and brass wire, and of many sizes, which is used for scale chain, jack chain, lamp chain, and many useful purposes at home, and is exported largely, not only to civilised countries, but is a favourite article of barter in the African trade, many a sable potentate owing much of his state and dignity to the product of this particular branch of Birmingham industry. This chain was formerly made almost entirely by women, and a good workwoman could make of a small-sized brass chain about six yards per hour, each foot containing about forty links. Machinery has, however, in this branch of the trade entirely superseded the hand-labour, and a machine tended by a child can make an endless chain, or rather a chain limited only by the supply of wire and the wear of the machine, at the rate of nine feet per minute, thus doing in one minute the work that formerly took a good workwoman at least half-an-hour.

The machine is far too complicated to be described without elaborate drawings, but is entirely self-acting, winding-off the wire from a coil placed on a revolving frame, and delivering the chain perfectly formed without any aid from the winder. It is difficult to estimate the quantity of chain used, but the sight of a large room filled with machines performing this operation only, and the knowledge of the rate at which the chain is produced, impresses the spectator forcibly with the idea that the quantity is enormous. There are a number of other articles, such as wire, nails, pins, staples, cotters, and many similar articles, which are now no longer made by hand, but which in their manufacture exhibit no particular points of interest, though they are additional instances of the ingenuity of the manufacturers of this locality, and of the extraordinary results of machinery in lessening the cost of production. Among the articles in the manufacture of which machinery is employed to a certain extent, and the part made by hand done on such a system that much of the old handicraft character of the trade is lost, are a number of articles that would at first sight appear not to be capable of such arrangement—bird cages for instance.

The old constructions of wood and wire are now largely replaced by cages made entirely of metal; and instead of the old tedious slow style of work, they are turned out with astonishing rapidity and simplicity.

A number of strips of zinc are cut about ½ or ¾ of an inch wide, and of such a length that they will, when bent, form a circle the diameter of the proposed cage. These strips are passed through a punching press, which pierces holes at equal distances on each edge; it is then passed through a pair of rolls which bend it into shape like a piece of moulding, or any other that the fancy of the designer may have suggested, and at the same time also shapes it into a ring. Three of these rings are then taken and the wires, having previously been bent to the form of the dome of the cage, are threaded through the holes, which, in consequence of the correctness of the machinery, are all true in position. The ends of the wires are soldered to the outside ring, the bent ends placed in the holes of the part forming the cap or centre of the top of the cage; the two remaining rings are slipped up the wires, one to the springing of the dome and the other half way up the sides, in which position they are soldered to the wires, and the body of the cage is done. The doors and frames for the seed and water glasses are made on the same principle of fitting, and the bottom of the cage having been spun in a powerful lathe, the different parts are put together, japanned, and ornamented. In making the materials and making these and the other kinds of bird cages, it is estimated that not less than 1,000 individuals are employed in Birmingham alone.

Some idea may be formed of the aggregate quantity of almost unnoticed articles by the fact that for wire springs for mattresses and upholsterers' purposes there must be considerably more than 1,000 tons of wire used annually, and that the wire made for tying down the corks of Soda Water, &c., weighs over rather than under, 500 tons; the length of which would be little under 100,000 miles.

Wire dish covers give employment to 400 to 500 hands. Fire guards are to be counted by the 100,000, and the miscellaneous articles of the trade are so varied, and are made in such numbers, by so many makers, that they defy all efforts to obtain anything like a trustworthy estimate of the production, or of the number of people employed.

[During the last few years several large manufactories have been erected for the production of infinite varieties of articles made from iron and brass wire. One of these (Geo. Baker and Co.) comprises nearly every branch of the trade, wire-weaving, garden seats, flower stands, &c. Formerly all these articles were painted and slowly dried, but Mr. Baker introduced a process of "enamelling," a sort of japan, which being perfected by the action of a stove, is much more firm and durable.]—EDITOR.

THE PIN TRADE.

BY THOMAS PHIPSON.

BIRMINGHAM has been long celebrated for the working of various metals, especially iron, copper, brass, &c., and the drawing and working of brass-wire has always formed an important branch of manufacture in this town. Wire-drawing and pin-making were commenced in Birmingham about the middle of the last century by the family of the Rylands, who carried on most successfully this branch of industry. The manufacture of pins was transferred by Mr. Samuel Ryland to his nephew, Mr. Thomas Phipson, about the year 1785, and this manufacture has since then been continued by the present firm of Thomas Phipson and Son.

It was customary a few years ago to quote the pin manufacture as one of the most remarkable instances of the division of labour, a single pin requiring for its production the successive manual labour of no less than fourteen persons, consequently giving employment to a considerable number of men, women, and children. This is no longer the case. In 1824 a patent was taken out in England by an American named Wright for a pin machine, which, during the revolution of a single wheel, produced a perfect pin. This machine was in the first instance far from perfect, and though it has been much improved upon at the present time, it was not rendered available before many thousands of pounds sterling had been expended in experiments at the manufactory, and many costly machines had been disposed of for the mere value of the metal of which they were constructed.

A pin may be defined as a piece of polished brass-wire of variable length and thickness, having a point at one extremity and a head at the other, and entirely covered with a coating of metallic tin.

In Wright's complete machine the entire pin is made. The principal shaft gives motion, in its rotation, to several sliders, levers, and wheels, which work the different parts of the mechanism. A slider pushes forward pincers, which draw wire from a reel at every rotation of the shaft, and advance such a length of wire as will produce one pin. A die cuts off this length of wire by the descent of its upper chap; the latter then opens a carrier, which takes on the wire to the pointing apparatus. Here it is received by a holder, which turns round, while a bevel-edged file-wheel, rapidly revolving, gives to the wire its first rough point; it proceeds immediately by a second carrier to a second and finer file-wheel, by which the pointing is finished. A third carrier transfers the pin to the first heading die, and by the advance of a steel punch one end of the pin-wire is forced into a recess, whereby the head is partially produced; a fourth carrier removes the pin to a second die, where the heading is completed. When the heading bar retires a forked lever draws the pin from the die and drops it into a receptacle below. The pin has now only to be "whitened" and "stuck," of which we shall speak presently.

In the machine we have briefly described, if it happen that any of the parts get out of order, the whole process is stopped until such portions are repaired. This source of inconvenience has induced the adoption of separate halves of the foregoing mechanism, and to use one machine for pointing and another machine for heading the wire. A number of the pointed wires are placed upon the feeder of the latter machine; one drops, is firmly seized, and by means of a pair of dies a portion of the metal is forced up, so as to produce a small knob at this end of the wire; the pin then passes, by an ingenious automatic arrangement, under a small horizontal hammer, which gives it a sharp tap on the knob, and completes the head.

Pointing is still occasionally done by hand. In this case the wire, supposing it to be already drawn to the requisite thickness, which is the affair of the wire-drawer, has yet to be straightened, in order to remove the curvature formed by winding it on bobbins or barrels. The straightening machine consists of a board, upon which are fixed six or seven upright nails, disposed in a waving line, so that the space measured in a straight line between the first three nails may have exactly the thickness of the wire to be trimmed, and that the other nails may make the wire take a certain curve, which must vary with its thickness. The workman, seizing the wire with pincers, pulls it rapidly through these nails, to a length of about thirty feet, which he then cuts off, and returns for as much more. The straightened wire thus obtained is afterwards cut into lengths of three or four pins, and delivered to the pointers. The hand pointing is executed on two revolving steel file-wheels, one coarse and the other fine, by one workman. The first wheel roughens down and the other finishes. Thirty or forty of the pin wires are applied to the file-wheels at once, arranged in one plane between the forefingers and thumbs of both hands, whilst a rapid movement of rotation is dexterously given to the wires. The latter being pointed at both ends are cut into two halves, and transferred to the heading machine already alluded to.

This method of pointing by hand, though it produces excellent work, is fast disappearing, as the machine now employed for pointing entirely dispenses with the somewhat long operation of straightening the wire. In England, the spinning of wire which was afterwards cut into detached heads to be punched upon the pointed wire by hand dies, has been entirely superseded by the manufacture of solid-headed pins, for like every other branch of manufacture that of pins must constantly progress.

The whitening is performed in a copper vessel placed on a fire, in which the pins are boiled in water along with grains of metallic tin and a certain amount of bitartrate of potash. When the boiling has continued for about one hour the pins and tin grains are removed, thoroughly washed, dried, and polished in bran. The latter is afterwards separated by a kind of winnowing machine.

Several kinds of apparatus are employed for sticking the pins into sheets of fluted paper, and for folding the paper for the wrappers, but as these do not specially belong to the manufacture of pins it is needless to describe them here.

[In another of the large manufactories in Birmingham—that of Messrs. Edelsten and Williams, and also that of Mr. C. Iles—hair-pins, hooks and eyes, thimbles, eyelets, fencing wire, bottling wire, and steel wire are respectively produced. In the former establishment two miles and three-quarters of brass wire have been produced from a three-quarter inch brass strip, and more than forty tons of iron and steel wire are used weekly, and three tons of brass wire for pins. As nearly three hundred persons are employed in this one establishment, if that of Messrs. Edridge and Merrett, and Mr. Iles and other smaller works are added to that of Messrs. Phipson, these trades employ more than a thousand hands.]—Editor.

MANUFACTURE OF IRON WOOD SCREWS.

By JOSEPH CHAMBERLAIN.

The manufacture of Iron Wood Screws, that is, of Iron Screws for use in Woodwork has, from its commencement, been carried on principally in Birmingham and the immediate neighbourhood, and now forms one of its staple industries.[*] Its progress, and the changes which have affected it, especially within the last sixteen years, afford a good illustration of a revolution which is taking place in the principal hardware trades, and which is assimilating the town to the great seats of manufacture in the North, and depriving it of its special characteristic, viz., the number of its small manufacturers, which has hitherto materially influenced its social and commercial prosperity as well as its politics.

Almost all Birmingham trades have sprung from small beginnings, and fifty years ago there were very few factories in the town of great size or importance.[†] The business was carried on in some part of the dwelling-house, or in small premises attached. The owner frequently worked himself, with his family and a few men; and these small manufacturers were more like the "chambermasters" of some London trades than the great mill-owners of Manchester or Leeds. Of late years, these factories have grown with extraordinary rapidity, the business has taken possession of house and garden, and the former occupant now lives out of town. Still, to this day, many of the largest works show their piecemeal origin; and the furniture of the old dwelling-house may frequently be seen in the counting-house or warehouse. The introduction of machinery, and the universal employment of steam-power, has necessitated two changes :—1st, the introduction of large capital into businesses which required little when hand-labour alone was used; 2nd, the construction of large mills, specially adapted to the wants of each trade. These innovations have brought with them the factory system, and it is probable that the change, which is deplored by some, and which is certainly leading to the extinction of the small manufacturers, as such, and is finding them employment as overlookers, or foremen in large establishments, is really an almost unmixed good.

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[*] Screws to drive into wood were made at Burton-on-Trent, before 1798, by Messrs. Shorthouse, Wood, and Co., the blanks being *forged* out of iron wire, for which they paid Messrs. Lloyds and Thornwill's forges about £500 per annum. Thirty pair of hands were employed in screw making. They also made screws at Tettenhall and Hartshorn, in Derbyshire, where they employed fifty-nine pairs of hands, and made 1,200 gross per week, by means of thirty-six engines or lathes, turned by one water-wheel, each cutting, with great velocity, eight or nine screws a minute, and was stopped eighteen times in that short period to put in and take out the screw. They were made of various sizes, from half an ounce to 30 lb. per gross. Children could earn, by the employment, from 1*s.* 6*d.* to 19*s.* per week. Before the present war iron screws could not be made fast enough for exportation; but they still make £100 per week, and have now (1796) a warehouse in Burton-on-Trent, stored with 4,000 gross. [Shaw's "Staffordshire, 1798."]—Editor.

[†] In 1780, Jennings and Co., 14, Snow Hill, appear as "Wood-Screw Makers."—Editor.

At all events, the following advantages will spring from its consummation — healthier work-places, regularity of hours, economy of labour, increased demand, lower prices, and at the same time higher wages. In fact, the salaries of foremen in many manufactories now are larger than the average profits of small manufacturers formerly. Having indicated the character of this change, it may be remarked that in no trade have the results been more marked than in that under consideration. At the beginning of the century, screws were made in small quantities by a laborious and tedious process, which must now be described. The wire was first cut into the required lengths, then the head was forged on the shank by a smith. A slot for the screw-driver to work in, called the "nick," was next cut by a hand-saw with fine teeth; and lastly the thread or "worm" was filed out by hand. The process of filing was supplanted in some cases by the following contrivance :—The screw-blank was held in a spindle which had a winch fixed to its other end; then in a rest screwed on a bench was placed a pair of cutting dies, the lower one fast and the other moveable. The moveable one was heavily weighted, but could be raised by a lever operated on by the foot of the workman. The blank being placed between the dies, and the upper one being brought down upon it by the weight, the workman turned the winch backwards and forwards till the screw was made. It was very hard work; and that and the twisting motion necessary got the workers the name of "screw-girders." Although the wages of the workpeople were low, yet the expensive and tedious character of these processes rendered it impossible for the screws to compete with nails, and consequently the sale was very small. The quality was also exceedingly bad, it being impossible to produce a well-cut thread by such means.

A great improvement was introduced some years later, and the screw-blank was held in the spindle, which was made to revolve by a treadle, while the worm was cut by a tool pressed against the wire by hand.

But this process was also laborious, and in the case of the larger sizes the treadle was necessarily worked by men. Still the thread was improved, and the operations more cheaply performed than by the file-cutting previously in use.

At last the introduction of steam power led to still further and more important improvements, the chief of which were the invention of a German clock-maker, named Colbert, and in 1849 the following description will apply to the processes then adopted. The wire was now brought to the works in coils, one end of which was introduced into a self-acting heading machine, which punched the head on cold, and cut off the "blanks" into the required lengths. The forged blanks so prepared were placed one by one in a lathe, and their heads were turned by means of cutters of the required form. After this process they were carried to the nicking machine, of which there were several forms, but the result in all cases was the same, namely, that the head of the screw was pressed against a revolving saw and held there for a sufficient time to cut the slot to the required depth. The nicked blanks were then placed separately in the worming machine, which consisted of a spindle with a regulating screw at the back end, and at the front were the "clamps" or pincers to hold the screw. Suitable cutters or dies were provided, which were forced by the worker against the revolving blank at the same time that by means of a lever a nut was engaged with the regulating screw, and thus the spindle was made to travel longitudinally at the same time that it was revolving. This process was repeated over and over again until sufficient metal was cut out to form a good thread. These processes were all performed by women, one to each machine, superintended by foremen and tool makers. They could be performed cheaply and rapidly, and the production and demand for screws was consequently much increased; but the article was still defective, inasmuch as the screws were not pointed or self-boring, and were very rough both on the top and under side of the head in consequence of the burr left by the nicking saw. It is computed that in 1849 the number of screws made in England was about 70,000 gross per week, and about 1,600 workpeople were employed in the manufacture, the majority being females.

In 1854 patent self-acting machinery was introduced from the United States, and effected a complete change in the extent and character of the manufacture.

The process may be shortly described. The wire having been headed by a machine similar in principle to the one described above, the forged blanks are carried to the turning and nicking machine, and are placed in a hopper above the machine, from which they are taken one by one by a mechanical arrangement which places them in the machine, where the heads are first turned, then nicked, and lastly, re-turned to remove the burr left by the nicking saw. The blank thus nicked and turned is then delivered by the machine into a bucket placed to receive it. All these operations are performed in one complete revolution of the machine, and the nicked blanks are thus produced in a single operation, instead of requiring three, as they would have done in the old-fashioned machinery. They are next carried to the worming machine, and placed in a hopper similar to that of the turning machine. Thence they are fed into the machine and a cutter is now passed along the blank often enough to produce a thread of the required depth, at the same time forming a point at the end; after which, the screw is taken out of the machine, and as in the case of the turning process, put into a bucket below it. By the improved process the screws are made better and cheaper than by hand. The machines being self-acting, one woman can attend to many of them, whilst on the old principle one attendant was required to every machine. The work is also much lighter, as it is only necessary to supply the hoppers with blanks, and to change the cutters from time to time as they become worn.

The machinery is, however, said to be very complicated and expensive. Large capital is consequently required, and no factory on this principle could possibly be worked profitably on a small scale.

The screws produced by these means have nearly displaced the old pattern, and have found a market in every quarter of the globe.

Probably not less than 130,000 gross per week are now made in Birmingham, and it is said that one firm alone manufacture 90,000 gross weekly, which is 30 per cent. more than the total make in 1849. More than 5,000 tons of wire are consumed yearly for this trade alone, and the screws made, if laid end to end, would reach to London and back once every three and a half days.

The "soife," or iron cuttings from the nicks and threads of the screws, average about four tons per day. This "soife" is bought up and melted down with other iron, the quality and toughness of which is much improved by the mixture.

The improvement in the machinery has of course diminished the cost of manufacture. The price of screws at the present time is about 80 per cent. less than at the commencement of the century, that is to say, the cost is about one-fifth of what it then was. Since 1849 the price has been reduced 50 per cent., and is now therefore one-half of what it was then.

The number of persons employed is probably about the same, but their position is higher and they are better remunerated, although the wages have always been good in this branch of industry. The number of women employed is much less in proportion to the number of men than formerly, as more of the latter are now required to repair and fit the machines.

The number of separate factories of any importance is now reduced to six.

The principal works are very large, the shops airy and well lighted and heated. The hours of work are sixty per week, and Saturday afternoon is kept as a half-holiday.

The total horse-power employed is estimated at about 1,000 horse-power indicated.

The tariffs of foreign countries have pressed heavily on the screw trade. In the United States the duty obtained by the influence of a wealthy company which has the monopoly of the trade is more than 100 per cent. *ad valorem*, and effectually precludes the possibility of importations.

On the Continent, in different parts of which the trade is largely carried on, the duties are considerable. The French Treaty, which diminished the duty on this article, has not benefitted the English manufacturers, as the shape of their screws is slightly different from the French and the foreign dealers are prejudiced against any change.

The introduction of the Factory Act is not objected to by the trade, although certain modifications might be desirable which would not affect the value of its more important provisions.

Closely connected with the manufacture of iron wood screws is that of brass and copper screws, and of screws for use in iron work, which are made in every conceivable variety. These trades are carried on by most of the manufacturers of iron wood screws, and there are also several small factories specially engaged in odd work.

[Since the above was written, the general Wood Screw trade has been absorbed in that of Messrs. Nettlefold and Chamberlain.]—EDITOR.

[The PATENT NUT and BOLT COMPANY, in 1864, purchased the business of Messrs. Watkins and Keen, who had removed from the Victoria Works, Smethwick, to the London Works, in order to carry out the manufacture of nuts and bolts by patented machinery introduced from America by Mr. Watkins. In 1865, the Company was amalgamated with the firm of Messrs. Weston and Grice, who had erected the Stour Valley Works some ten or twelve years previously, their original works at Overend having been found inadequate to meet the demand for railway-fastenings consequent on the introduction of the fish plate joint. The Company, at its various works, produced bolts and nuts, rivets, coach-screws, washers for engineering, ship-building, carriage and waggon-building, bridges, &c., &c., both for home and exportation.

In nut-making, the pig-iron, after being puddled and rolled in the usual manner, is placed in a reverberatory furnace, rolled to the required size, and while hot placed into the patent machines, by the action of which the piece of iron to form the nut is cut off, forced into a square, hexagonal or octagonal die-box, and punched simultaneously from both sides while under the necessary pressure. The advantages of the process are the greater cohesive strength arising from the hole being forced into the nut, thereby solidifying the metal,—the certainty with which the hole is made exactly central, as well as true and smooth throughout,—the regularity and equality of the angles,—complete uniformity of size, and rapidity of production. The last is such that from fifty to eighty nuts can be produced per minute, varying in size from one-quarter into three inches in diameter, and it is said that if necessary twenty tons of each size could be despatched on the day the order was received.

Bolts, spikes, and rivets are also produced at a single blow by other machines, the head being formed out of the solid iron; vertical revolving or horizontal self-acting screwing and tapping machines being employed for the subsequent operations on the bolts or nuts, by which a highly finished thread is given with such uniform exactness that all articles of a given size and description are interchangeable.

About 2,000 tons of manufactured goods are said to be turned out of the company's works per month.]—EDITOR.

PATENT WROUGHT-IRON HINGES.

By F. E. MARTINEAU.

The manufacture of wrought-iron hinges seems to have been carried on in Birmingham and the neighbouring district for many years, but it is not here intended to speak of the whole trade. Therefore, before treating of the subject of this paper, it might be as well to describe the two other methods by which these articles are made.

First, there is the welded hinge, in which each flap is made by bending on itself thin iron cut to a suitable form, and uniting the parts brought together by welding, leaving the bend open to receive the pin and make the knuckle. The action of the fire in this work necessarily leaves it rough, and much labour, with some skill, is requisite to make well-finished articles. Birmingham used some time since to make a quantity of this kind of hinge, but at the present time but few are produced. Wolverhampton, and some other places in the district, still carry on this trade extensively. Ashton, in Lancashire, also manufactures them largely; and they are made to a small extent near Newcastle-upon-Tyne, and in Scotland.

The second species of wrought-iron hinge is that known as the "pressed rivetted." The material here is treated in a very similar manner, but the flap instead of being made one by welding is united only by rivets. This method is more in use for the smaller and cheaper kind of hinges. The trade belongs more particularly to Birmingham. Scotland, until recently, making a good many, principally for its own consumption.

The "patent" wrought-iron hinge, as it is commonly called, is made upon an entirely different principle to the first-mentioned articles; and the manufacture of these has settled itself almost, if not entirely, in Birmingham. It is much more recent than the above trades, and dates only from about the year 1840. The invention is generally supposed to have come from America, and there is no doubt that some of the first makers received their knowledge thence; but, at the same time, an independent English invention led to the manufacture of an identical article here.

The formation of this hinge may be shortly described thus:—Suitable iron is cut to the figure of the required pattern, having the parts that are to make the knuckle projecting as tongues. These tongues, by being forced lengthways into properly shaped dies, are curled over in such a way as to make a place to receive the pin upon which the flap is to turn when the hinge is put together. Thus, cheaper and more sightly articles are produced than in either of the previously described plans, and but little finish is required to make them ready for sale.

It is, to a great extent, to this neatness of appearance, combined with the lowness of cost, that this trade owes its increase during the last few years. These are constantly being substituted for the welded hinges in various places, at the same time that they are being sent in large quantities to new markets. Thus, hundreds of grosses are now going to the more distant parts of the Continent to be used, not instead of any other kind of hinge, but in the place of the primitive contrivance of osier or cord ties, which have, until the present time, answered for hinges.

The increase in this trade will be best shown by the quantity of material used in manufacture, which quantity, though it would be impossible to give it correctly, may be roughly estimated as follows:—At the time of the former meeting of the British Association in Birmingham (in 1849), this manufacture consumed about 700 tons of iron per annum in this town, but at the present time (1865) not less than 2,500 tons are converted into hinges on this principle.

Patterns vary very much, and are made to suit the fancies of the various buyers, and it is curious to see how certain places continue to require articles made of the greatest quantity of material (used in such a way as to be of the least possible advantage in strength), and neglect patterns which seem much cheaper and are certainly more durable.

There is a large home trade in these goods, especially in the North of England and Scotland, and Ireland buys certain patterns to a great extent. The sale on the Continent has increased much in the last few years, but the French do not take many, most likely because they manufacture similar goods. The United States of America are now entirely shut against us; they make for themselves. In South America there is a very extensive sale, the various ports on the East coast having patterns peculiar to themselves, whereas quite another class of article is sent to the West coast. The West Indies and the adjacent countries buy largely. East India is an increasing market. Of our Colonies, the Canadas, Australia, the Cape, and New Zealand, buy regularly and increasingly of goods similar to those sold at home.

The competition with foreign countries is not very great. In some parts of the Continent French and German goods are mostly used, and some of the lighter of their makes compete with ours in South America. The United States supply Canada to a considerable extent.

There are about 300 people employed in this trade in Birmingham, of which one-third are women and girls. The work, being heavy and dirty, is not very attractive to the more respectable portion of the female working population of the town; and as the greater part of the labour of the men and boys requires but little skill, the workmen are not of a very high grade.

The wages earned differ considerably; but few of the principal men employed, when in full work, get less than 30*s.* per week, after paying the boys, who mostly serve under them. Women's and girls' wages vary from 10*s.* to 5*s.* per week, according to the nature of the work.

South Staffordshire supplies the chief part of the material used. It is mostly in the form of strip iron, which requires to be of such a soft and pliable nature as to stand without cracking the cold bending to which it is subjected. Small quantities of bar, round, and slit-rod iron, as also of drawn wire, are used. It is a necessity to the trade that there should be a good market for the large quantity of scrap made in the course of manufacture, which is mostly fitted for forgings of the best kind.

CUT NAILS.

By R. F. MARTINEAU.

In making nails, as in many other branches of manufacture, the Americans discovered before the English the advantages of machinery. Before the year 1811 all our nails had been forged out of hot iron on the anvil, by hammers; but in that year the process of cutting them out of cold metal by machinery was begun in Birmingham. In some details the machines have been improved since that time; yet in principle and all essentials they are the same. But the simplification of parts, and acceleration of speed, have had such an effect on the cost of production that in some kinds of nails the prices are now only one-fifth of what they were forty years ago. The manufacturer's success depends almost entirely on the perfection of his machinery; and, while some few masters have done well, there is scarcely another trade in Birmingham in which the proportion of failures has been so large.

The manufacturer buys his iron in sheets about six feet long, by two feet wide; these are cut across into parallel strips. If the nail to be produced is required with a flattened head, the width of the strips is a little more than the length of the nail, to allow the re-arrangement of the particles under pressure to form the head; thus a 1-inch box, or "clout" nail is cut from a strip about 1¼-inch wide. But there is one variety which, having no projecting head, and being the simplest form made, we will consider first. It is the "bill." The name "sparrow bills" was first applied in the exuberance of our forefathers' fancy, to a particular sort of *cast* nails, from their bearing a distant resemblance to that ornithological member; but the only approach in form to the "cut bill" that we can find among birds, is the closed bill of the heron or stork. The "bill" is merely a narrow wedge of iron—a woefully attenuated letter V. It is used chiefly for the heels of boots. There are two sorts of machines which cut this kind of nail. In the older one we see the strips of iron laid in a grooved platform sloping down to the machine, towards which they are pressed by a weight behind them till they are stopped by a steel plate. They are thus presented to cutters which come down in front of the plate, vertically, but not at right angles to the strips, thus cutting-off from the ends of the latter triangular slices—in fact the required shoe bills. As the cutters rise they are turned partly round, so that the next cut shall be oblique in the opposite direction from the last, and shall form the wide end of the forthcoming nail from the side of the strip where the point of the last was. Thus the cutters rise and fall, alternately presenting right and left shoulder forward, and the parallel sides of the strip form a succession of alternate bases and apices of that isosceles triangle, whose familiar name is "bill."

The wear and tear of this machine are very great, and the sort now preferred is one in which the cutters always come down in the same place; and the strips are laid on a frame moving backwards and forwards in the segment of a circle of which the cutters are the centre. When the frame moves to the right, the cutters take off a bit of the strip wider at that side; the frame then traverses to the left, and the left side of the strip then furnishes the head of the nail. Thus it will be seen that in the machine first described the alternate oblique cut is given by change in position of the cutters; and in the second by the differing direction in which the strips are presented. These latter carry five strips at once, and can cut about 1,000 bills (of the smaller sizes) per minute. They only require a boy to keep them supplied with fresh strips.

Nails, however, in which the larger end has to be flattened into a head cannot be made by so simple a machine. After the nail is cut out taper it is carried down, and pressed by a pair of nippers, which form the neck; while a sort of hammer comes and strikes the head into shape at one blow. It is not possible to use more than one strip at a time to each machine of this kind, so it is fed by a boy or a girl, who turns over the strip after every cut, and thus causes the cutting of alternate head and point from each side of the strip. These machines vary in speed according to the size of nail cut; but as an instance of marvellous rapidity we may mention that of small tacks—240 are made in a minute; that is to say, the strip is turned over and pushed forwards four times in a second.

The nails being thus made the only process required to finish them is that of annealing, to give them a rich blue colour, and render them, to a slight extent, malleable. This is done by heating them red hot in an iron box made perfectly air-tight. At a slightly advanced price cut nails might be supplied which would clench like any wrought iron nails, and some few are made thus; but the price at which most are sold does not allow much consumption of fuel, and they are therefore generally annealed in a most imperfect manner. On some accounts *cut* nails are better than wrought; the latter being smooth split the wood into which they are driven much more than the former, the rough edges of which *saw* their way in with comparatively little splitting.

From 15,000 to 16,000 tons of iron are annually cut into nails in Birmingham. This is nearly three times the production in 1849. About half the quantity is for the home trade; India and Australia take a large proportion of the rest. The heavy tariffs of most European countries, of South America, and latterly of the United States, render large exportations to those quarters impossible. During the recent war, when labour was so dear in America, there was a better demand than usual for English cut nails, both there and in the West India Islands. The most interesting circumstance about this trade in connection with foreign countries, relates to France. Some years ago a Birmingham manufacturer went over there to see what his French opponents were doing. He found that the duties on English cut nails were so high as to amount to a prohibition; that the importation of English iron was also heavily taxed; but labour was so cheap, that with his knowledge of machinery he could have made a fair profit by setting up a manufactory there. Good workmen were getting only 1*fr.* to 1½*fr.* a day. The French consumer must therefore have been paying very highly for his goods. Now, with free trade, the French are actually selling us cut tacks here in England, made of English iron, cheaper than we can make them. Probably this will not continue long, as the French workman will find that he is getting too little wages. It is especially in small tacks that the French sell lower than the English makers. Immense numbers of these are now being used for boot making; the boot is made on a steel last; tacks a little longer than the thickness of the leather are used to fasten the sole to the upper leather, and driving them through against the hard surface of the last turns their points, thus firmly rivetting the two pieces of leather. These tacks are made as small as three-sixteenths of an inch, weighing 1¼oz. per 1,000. From these, the smallest variety, cut nails are made up to 8in. "spikes," weighing 1cwt. to the 1,000; and reckoning all the sorts and sizes, in the various materials of iron, brass, copper, and zinc, there are now over 2,000 different kinds made.

The manufacture is likewise carried on at Wolverhampton, Leeds, Newcastle-on-Tyne, and in Lancashire. It is estimated that the quantity made in these places would together about equal the production here.

The trade employs about 600 men in Birmingham, and the same number of women and boys together. Skilled men, accustomed to superintending machinery, can earn 25*s*. to 50*s*. a week, while labourers get 15*s*. to 20*s*; and women and boys, 10*s*. to 15*s*.

[Some of the earliest experiments in making cut-nails by machinery were made in Birmingham, and at a heavy cost and serious loss. The first cut-nail works were established in a large building, still remaining in Blews-street, off Aston-street, about forty years ago.]—EDITOR.

PEWTER AND BRITANNIA METAL TRADE.

By THOMAS YATES.

The manufacture of articles from tin is of very ancient date. The trade was most probably brought to this country by the Dutch, and the metal used was termed pewter—a word of Dutch origin. In the year 1482, the pewterers were incorporated as the Sixteenth Company of the City of London, and from that period to the present the metropolis has remained the chief seat of the manufacture.

The staple articles in demand were plates and dishes, with a variety of vessels used for domestic purposes, which, prior to the more general use of earthenware and china amongst the higher and middle classes, must have had an extensive sale. The trade was commenced at Manchester, and is still carried on there. It was also established at Bewdley, but has been given up about twenty years. At the close of the last century, one branch of the pewtering trade was introduced into this town, and in the year 1814 a maker of candle-moulds is registered in the Directory. The other branches of the business were subsequently added, and in the year 1828 there were four manufacturers employed in the general trade.

There is scarcely any business, not actually obsolete, which has been more changed by fashion than this. Plates and dishes, which were at one time the staple production, are now made only in small quantities for a few foreign markets; and latterly the trade has been chiefly engaged in the manufacture of ale and wine measures, drinking cups, and other requisites for hotel purposes. A very considerable branch is now employed in fitting up refreshment stores with beer engines, liquor fountains, and other conveniences belonging to those establishments; the mechanical contrivances employed to facilitate despatch of business being not more remarkable than the elegance and style with which the improvements are carried out.

The operators engaged in the manufacture of pewter goods only, are confined to a very limited number in consequence of the exclusive regulations which they adopt in reference to the supply of labour. The chief seat of the trade is in London, and here, as there, the rules of the operatives' society exclude the introduction of any apprentice, unless he is the son or representative of a member. This arrangement acts prejudicially, as the trade cannot be extended under such restrictions, and hence many articles formerly made in pewter are now superseded by similar utensils made of other materials.

There are but few, if any, improvements in the processes of manufacture since its first establishment. The article is cast in a mould made of brass or iron, as nearly as possible of the ultimate shape required. It is then placed in a lathe and turned to the pattern, size, and weight required.

The finishing is done by burnishing. No females are employed in any department.

The discovery of gold in Australia had a considerable influence in promoting the pewtering trade. From the substantial character of its manufactures, they were suited to the requirements of the colony, and a considerable trade was at once commenced. The demand is still steady and increasing, especially as regards ale and wine measures, drinking cups, &c. The French Treaty has not been beneficial at present; the strength of these goods being at a disadvantage when assessed for customs by weight, consequently articles of a lighter description made in Britannia metal are more generally in demand for that market.

In addition to the articles already mentioned, there are a variety of others made by the pewterers, although the demand is somewhat limited, such as syringes, inkstands, hot water bottles, funnels, soup tureens, hot water plates and dishes, freezing pots and other requisites for the use of confectioners, jugs, basins, and chamber services for hospital and ships' use. A teapot is also made by them, called the Dutch pattern, which being formed in one piece by casting is of great strength and very durable; and although the shape has been copied in a lighter article made from rolled metal, there are some markets in which it still holds the pre-eminence, although of a most primitive design.

Before gas became generally used, and during the early introduction of Argand and other similar lamps, a very considerable trade was carried on in the manufacture of moulds for the production of candles. These were made by casting the pewter into the shape of a hollow tube, which was afterwards bored out and polished in the interior. A nozzle was then added to the tube to produce the taper shape at the top round the wick in mould candles. Of late years this demand has fallen off; a few sets are occasionally made for the Australian market, but those which are used by the patent candle makers are of different materials, and do not form any branch of the pewtering trade.

The material used in the Britannia metal trades, properly so called, is closely allied to that employed by the pewterers; but the mode of manufacture, and the different class of articles produced, render it distinct and separate. As a trade, it is, undoubtedly, of more recent origin than pewtering, and has been progressive from its first establishment, which may be dated about the middle of the last century. Prior to this, there were teapots and other articles made of copper, and silver plated; but these were so expensive as to approach very closely in price to similar productions in sterling silver, and, generally, the tea service included pots made of china or earthenware. These were, however, liable to fracture; and, therefore, the introduction of a metallic substitute must have recommended itself.

The production of Britannia metal wares was first commenced at Sheffield, about 1770—when Messrs. Hancock and Jessop entered on the manufacture, on a large scale—for several years, the only place from which articles made up from rolled sheets of metal were sent out. The earliest process was to stamp the metal in dies of the intended shape, each part afterwards being soldered up, and the desired pattern completed. This process was complicated, and involved a great amount of labour, which, consequently, rendered the articles high in price, and, therefore, of limited sale. This mode of manufacture continued until the beginning of this century, when an improvement was made, which almost entirely superseded it. This was the application of the ancient potters' wheel to the material, a process still followed, and known by the title of "metal-spinning." A block of wood, called a chuck, was turned to the desired shape, in a lathe; a piece of flat-rolled metal, of a uniform thickness, was then placed upon the wood, and by pressure from bright steel, hardwood, or bloodstone tools, the metal was gradually forced down to the wood block, and completely shaped as required. By this plan, the cost of labour was materially lessened, and the trade placed in a more favourable position, the demand largely increased, and the use of tea and coffee pots made in Britannia metal, together with cruet frames, side-dishes, &c., soon became an important branch of manufacture.

Towards the close of the last century the trade was begun in this town, but it does not appear to have made much progress at the outset, as the Directory for the year 1814 only records three makers; but in the fourteen years subsequently the number had increased to nine. During this period, and for some years after, competition with Sheffield was active, but in the superior class of articles unsuccessful, and the trade could not be recognised as one in which the town might claim particular excellence. Several improvements and new processes were, however, introduced and patented at a later period, which gave a considerable impetus to it. An inferior class of articles was superseded by the introduction of manufactures in tin-plate, formed by a patent process, when polished resembling similar goods made in Britannia metal. A patent was also obtained for ornamenting sheets of metal by means of rolling designs from hard steel rollers upon them, which when the sheets were made up had a novel appearance, and for some considerable time a large sale. This was afterwards followed by a process for casting, in a solid piece, all kinds of hollow articles, such as tea-pots, sugar-basins, &c., with designs in relief. These novelties were undoubtedly beneficial to the trade, but it is to the introduction of electro-plating that its success must be chiefly attributed. The old process of close plating, which was performed by heat, was impracticable with Britannia metal as a base, and when the new process enabled the manufacturer to adopt ornamental designs, which were unfit for unplated articles, the trade at once assumed a new aspect, and style and design were required to produce articles having a claim to elegance. It also considerably enlarged the purposes to which the metal could be applied by the makers of candelabra, flower vases, inkstands, and a variety of other goods—as the pattern, however intricate, was no obstacle to the new plating process. From that time there has been a steady improvement in the style and quality of the numerous articles produced, and the Birmingham manufacture is now equal to any competition. By the employment which it affords to other trades, glass-making, embossing, electro-plating, &c., it contributes in an important degree to the general prosperity of the town.

Another branch of the Britannia metal trade was the manufacture of spoons and ladles, and in the early part of this century upwards of a dozen firms were engaged in this business, which was then of considerable extent. The process employed was to cast the spoons in moulds made of brass, the scraping and burnishing being afterwards effected with steel tools. This plan necessitated the employment of much hand labour, until the introduction of polishing by steam power greatly reduced the number of operatives. The decline of the trade is to be attributed in chief to the introduction of German silver, which gradually superseded the use of spoons made in Britannia metal. In 1837 the principal foreign market was the United States, but at that time a heavy duty was imposed which was prohibitory in its effects, and resulted in closing the greater proportion of the manufactories here. Since that time the improvement in the make of German silver spoons has still progressed, and from the increased facilities for their manufacture they have now become nearly as low in price as Britannia metal. The introduction of a still cheaper article, made in brass, and coloured white, has also had the effect of reducing the trade to a very limited extent.

The component parts of the metal, termed Britannia, are nearly the same as when first introduced, except, perhaps, that bismuth is now but rarely used. It generally consists of about ninety parts of tin to eight of antimony and two of copper, but these quantities are varied by different makers. From the large proportion of tin it will be seen that the price of that article exercises an important influence upon the cost of the productions, and, until recently, the price of tin was subject to rapid and excessive fluctuations. Commencing with the year 1849 the price was £74 per ton; but in 1857, after a constant succession of advances and reductions, it had reached the high price of £146 per ton, and with a limited supply. Latterly, however, prices have become more uniform, which may be attributed to the increased supplies from the Cornish mines, together with the supplemental importations of foreign tin from the Dutch settlements of Banca, and from the Straits of Malacca. After being cast into ingots or slabs, the Britannia metal is rolled into sheets of the required thickness by being repeatedly passed between heavy polished steel rollers.

The operative department in this trade is exclusively confined to men, and as a class they are intelligent and industrious. In the polishing or finishing processes* females are employed.

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* Besides the "spinning" already noticed, the principal processes employed in the manufacture are "swaging," for producing flutes and embossed or raised ornaments, performed by a large fly-press, one workman applying the metal between the punch and boss, while another works the press, "stamping," "casting," "soldering," and "buffing."

The supply of labour is sufficient for the demand, and but rarely in excess, as the introduction of apprentices indiscriminately is carefully avoided by respectable firms.

Although latterly a cheap description of electro-plated goods in German silver and brass have competed with similar articles made in Britannia metal, still the trade has not suffered to any perceptible extent. The Australian markets are still taking considerable quantities, and more recently the French treaty has enabled the makers to compete with their Continental opponents. There was some difficulty experienced at the outset in providing suitable patterns, but now that the markets are better known the manufacturer is better enabled to satisfy the taste and fashion of his customers.

Besides the articles already more particularly referred to, many others are made in Britannia metal, both for use and ornament. Amongst the hollow-wares may be mentioned hot-water kettles, soup tureens, gravy dishes, every variety of vegetable and side dishes, with and without warming apparatus; dram bottles, drinking cups, wine coolers, sandwich cases, soap boxes, and other miscellaneous goods for every purpose to which the metal may be applied. There is also a considerable trade carried on in requisites for the table, such as liquor frames, hot-water jugs, trays, waiters, mustard-pots, salt-cellars, &c.; considerable taste is displayed in the production of candlesticks, candelabra, fruit baskets, card trays, flower vases, and other things of a similar class. The facility with which these articles are made, being chiefly cast in moulds, and the suitable character of the metal to receive the electro-deposit of silver, render the price very moderate, and place the acquisition of really elegant, useful, and durable manufactures within the reach of almost all classes.

In connection with this trade may be mentioned the attempts which have been made, during the last few years, to obtain a cheaper kind of metal as a substitute for Britannia metal. One method adopted was to coat a thick substance of lead with a thin film of tin, and by means of pressure by rolling the two metals were uniformly extended, and so made

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The "buff" is a solid trundle of wood, about a foot in diameter, and two inches thick, covered on the rim with buff or other thick soft leather. This is fixed on a spindle, and made to revolve rapidly. The article to be "buffed" or polished is held against it so as to expose every part of the surface to the friction. For getting into the flutes, corners, &c., solid discs of leather, generally walrus or sea-horse leather, are employed. These vary in size from two to six inches in diameter, and taper towards the rim. Where the buff cannot be used, circular brushes are substituted, fine sand from the bed of the Trent being employed. After being washed and brushed in boiling water, with soft soap and alkali, the articles are finished by hand-polishing, with soft soap, a little oil and powdered rotten-stone, the last touch being given by the hand alone.—EDITOR.

to resemble externally the usual appearance of Britannia metal. Upon its introduction into this trade, it was found inapplicable to any purposes where soldering was required, as the action of the blow-pipe at once removed the thin coating of tin, and exposed the lead underneath. In the manufacture of coffin lace, it is still extensively used. A similar metal to this is the celebrated Patent Capsule Metal, of which Mr. Betts is the proprietor, his right to the same having been, however, frequently contested in the Law Courts. With these exceptions, and those only available in certain branches, there has not been, as yet, any method discovered to reduce, by amalgamation with alloy of some cheap description, the price of Britannia metal, without by such mixture destroying the bright appearance, and entirely removing the clear ringing sound peculiar to good Britannia metal.

MANUFACTURE OF IRON AND BRASS BEDSTEADS.

BY EDWARD PEYTON.

IRON Bedsteads have been long made for use in Hospitals, Workhouses, and Barracks; but it is not more than thirty years since the trade was fairly established, and iron and brass bedsteads began slowly to find their way into the houses of the middle and lower classes, and the less important sleeping rooms in the best houses in the country.

One of the advantages which metal bedsteads possess is the facility with which they can be put together, or taken down, owing to the simplicity of the joint by which the several parts are united. It is a simple dovetail joint, and consequently requires no nut, cotter, or other loose part liable to be lost or to get out of order; and its superiority over its predecessors is attested by the fact, that except in officers' bedsteads, those for lunatic asylums, and some few other special cases, it has superseded all others.

At the same time that the dovetail joint was adopted, a very convenient and cheap method for making the head and foot rails of iron bedsteads was introduced. This consists of uniting the separate parts of the rails consisting of pieces of rod iron, round, oval, or any desired section, by means of castings in chills or iron moulds. As frequent repetition is required, the labour and expense of uniting the various parts by forging or moulding in sand is avoided, and the castings themselves may be, and usually are, of an ornamental character. From the date of the introduction of these improvements, about twenty years ago, the trade has developed rapidly.

In 1849, there were not more than eight manufacturers who could be fairly reckoned as established in the trade, and of these four or five belonged to Birmingham. Since then, the number of well-known makers in this neighbourhood has increased to twenty, and the number of finished articles produced weekly from about 400 or 500, to 5,000 or 6,000.

While the number has so greatly increased, the quality also has improved, though the processes of manufacture are substantially the same as they were twenty years ago.

The chief alterations since that date are the introduction of malleable iron castings into the head and foot rails of the most expensive goods, the admixture of brass and iron, and the use of an adaptation of lithographic printing for ornamenting the posts and other parts of bedsteads with scrolls, wreaths, or flowers, either in gold or colours. This is a patented process which is in use also in the general japan trade, and, so far as iron bedsteads are concerned, is in the hands of one firm only.

Besides the improvements which have been mentioned, no change has taken place in the manufacture perceptible to the public. There are of course various contrivances in use for reducing the cost of manufacture, the most important of which, belonging as it does to the most peculiar feature of the trade, viz., the casting in chills, consists in the form and arrangement of those chills. Probably, however, the manufacturers who have made the greatest advance in this direction would be the least disposed to enter into explanation on the subject.

It cannot be said that there is any special machinery used in the trade. The chills, already referred to, are rather tools than machinery, and the only machines used, in addition to ordinary lathes, drills, &c., for assisting hand labour, are those for producing the various tubes for the posts or pillars. As these are, without exception, applicable to other purposes, the machinery would more properly be described under the head of tube making.

As bedsteads are articles for use, and except in the patterns of such parts as can be rendered ornamental the chief features in all must be similar, there have been few vagaries in their manufacture. The chief or only noticeable one was in the bedstead which caused so much amusement in the 1851 Exhibition, so contrived, that by the removal of a pin the foot end fell to the ground and threw the occupant on the floor. This was effected by clockwork, which could be set to go off at any hour desired, like an alarum, and was intended to facilitate early rising. It was expected to be patronised extensively by hotel keepers and others who had a difficulty in getting their servants up in proper time. This anticipation, however, proved too sanguine.

In this trade it is not usual to employ women, except as japanners, lacquerers of the brass work, or wrappers-up in the warehouses.

Within the last twenty years the improved methods of manufacture and the growth of the trade have reduced the cost quite one-half, but any further appreciable reduction does not seem probable, hardly possible. Indeed, the tendency is rather in the other direction, as, the lowest point in the cost of production having been reached, it is the policy of at all events the more enterprising manufacturers to secure trade by improving their goods rather than by lowering prices.

As already stated, the present production is probably from 5,000 to 6,000 weekly, and these are absorbed in nearly equal quantities by the home and foreign trades, or perhaps three-fifths by the former and two-fifths by the latter.

The export trade is greatly restricted by foreign tariffs. In the greater part of Europe little is done, though but for the duties imposed there would probably be a fair trade with France, Austria, Italy, and Germany. With Spain a considerable business has been done for many years, but the last alteration in the tariff has had the effect of reducing the trade except with regard to the most expensive goods, chiefly brass.

With the United States there has never been any trade, as the duty levied even before the war was practically prohibitory. The chief foreign trade is with our own Colonies—Australia, New Zealand, The Cape, Mauritius, Canada, and latterly with the East Indies. There is also some considerable trade with the West Indies and the States of South America, both on the east and west coasts.

In England, the manufacture is chiefly confined to Birmingham and the neighbourhood. There are a few manufactories in London, and some very small ones hardly worth notice in other large towns; but nowhere except in Birmingham and London, and hardly in London, can the manufacture be said to exist as a trade. It is carried on in various continental countries, particularly in France, Italy, and Spain.

In Birmingham, there are probably from 2,000 to 2,500 persons employed in the manufacture, without reckoning the subsidiary trades of tube making, malleable iron casting, &c. Of these, about half are boys, and one-sixth girls and women. But little highly-skilled labour being required, and so large a share of the work being done by boys and women, the average earnings of all employed are not high, probably not more than 15*s*. or 16*s*. weekly. The average earnings of the men would not exceed 24*s*. or 25*s*., many of them being little more than labourers.

With regard to the social condition of the workpeople, there are two points worthy of remark. One is that though a practised hand can do better for himself and his employer because he can do more in a given time, there is nothing in the trade except the ornamental japanning which requires an apprenticeship. Any man who can use a hammer and file can be a bedstead maker. The other point, which is to a great extent a consequence of the former one, is that there is no trade union.

These circumstances are beneficial to employers, but no less so to the employed. Every man stands upon his own merits, which are not only skill and despatch in work, but sobriety and trustworthiness.

Every one accustomed to deal with work passing through several hands, when each is dependent upon the others, knows how much depends upon the steadiness and regularity of his men; hence the moral and intellectual qualities of an artisan have a money value to his employer, and from the lowest point of view deserve recognition, if not direct remuneration, as well as mere dexterity with his tools.

In this, as in many other departments of production, the tendency is in favour of large factories, in which alone the full benefit can be derived from the use of machinery and expensive tools, and the arrangement and division of labour carried out on the most profitable system. Under such conditions, a great object must always be that all shall work together as nearly as possible as though moved by one will, and it may therefore reasonably be hoped that the value of steadiness and regularity will be more and more recognised by both masters and workmen. Such a recognition cannot fail to prove one of the most cogent, because most direct and appreciable influences in the improvement of the moral and social condition of the labouring classes.

MEASURING RULES.

By J. RABONE, Jun.

Of the early history of this manufacture it may be sufficient to state that until the early part of the seventeenth century, at which time Edward Gunter invented the line of logarithms graduated upon a sliding scale, which solves problems instrumentally in the same manner as logarithms do arithmetically, the trade never assumed sufficient importance to cause it to be followed by persons who had no other occupation, and to make it worthy of being designated a craft. Up to that time the best measures had been made by the mathematical instrument makers; but this ingenious invention of Gunter, by reason of its universal applicability to measuring purposes, called into existence another class of workmen, superior to those who had hitherto chiefly made the notched sticks similar to those used in many rural districts at the present day, but still somewhat distinct from the opticians and makers of such instruments as quadrants, sextants, and the finer kind of optical and mathematical instruments. The first men who were worthy of the name of rule-makers were to be found only in London; but after a time the trade gradually extended itself to Wolverhampton and Birmingham. Under date of the 10th of August, 1664, Mr. Pepys records in his diary his experience of the scarcity of competent rule-finishers (as the men who make the rules are called) in London. He writes :—

> "Abroad to find out one to engrave my tables upon my new sliding rule with silver plates, it being so small that Browne, that made it, cannot get one to do it. So I got Cocker, (the celebrated arithmetician and) famous writing-master, to do it, and I sat an hour by him to see him design it all; and strange it is to see him, with his natural eyes, to cut so small at his first designing it, and read it all over, without any missing, when for my life I could not, with my best skill, read one word or letter of it."

And then on the next day Pepys writes :—

> "Comes Cocker, with my rule, which he hath engraved to admiration, for goodness and smallness of work; it cost me 14s. the doing."

From the fact that Browne, the mathematical instrument maker, was unable to find anyone to engrave Mr. Pepys's sliding rule, it is to be supposed that the art had not then attained to much perfection, or rather that proficiency in it had been made but by few. In 1755, nearly a century later, is recorded that even in London "it was a most difficult matter to get rules good, there being only one man who could make them perfectly well, and he had lately taken to other work." In July, 1755, James Watt found his first employment in London as a rule-maker, under Mr. John Morgan, of Finch-lane, Cornhill, of whom Watt writes to his father, that "though he works chiefly in the brass way, yet he can teach me most branches of the business, such as rules, scales, quadrants," &c. In less than two months after his arrival in London Watt says he had made a brass parallel rule eighteen inches long, "and a brass scale of the same length." By December he "could work tolerably well," and "he expected that by April he would understand so much of his business as to be able to work for himself." When June had again come round, and within twelve months of his first attempt at rule-making, Watt wrote to his father, that "he could now make a brass sector with a French joint, which is reckoned as nice a piece of framing-work as is in the trade." Watt, however, having doubtless acquired proficiency in the art of rule-making, did not "work for himself," as it appears he intended to do, but turned his attention to the improvement of the steam engine, and thus conferred greater benefits upon the world than he would, had he continued the manufacture of "parallel rules," or even "sectors with French joints." It may be interesting to know that the sliding rule, long used by James Watt, is still preserved in Birmingham, in the possession of an eminent founder; and it is still used as a check in testing calculations. Is it not probable that this rule may be the handiwork of its former great and famous possessor? Five and twenty years later the finer kind of measures were still made in London by the instrument makers; but the more ordinary kinds of carpenter's rules were manufactured almost exclusively in Wolverhampton. At the latter part of the past century only three or four rule masters, each employing a few apprentices and men, were to be found in Birmingham, and one at Harborne adjacent; but now the trade has almost deserted Wolverhampton, which numbers only four or five persons employed in it, while Birmingham affords employment to as many hundreds. With the exception of three or four makers scattered throughout the country the trade is now entirely confined to Birmingham and London. Many of the rules sold as London-made are produced in Birmingham, and many are framed in Birmingham and sold to the London makers, who mark or finish them themselves. The joints of the earliest made rules were cut from the wooden pieces which formed the legs, and brass plates were attached to the outside to strengthen the otherwise weak and wooden joints. Afterwards the joints were composed of metal, and attached to the wooden sides, instead of being made out of them. The joint, so well-known as the arch-joint, and which is seen upon so great a number of joiners', and other rules, was first made about sixty years ago; yet in a celebrated modern painting representing the early printers at their labours in Westminster Abbey, we find an accurate representation of a two-feet rule with this kind of arched joint, the artist being unaware that it was not invented till more than 300 years after those early printers had distributed their last form.

The general shape of rules has been but little varied, the convenient arrangement of two or four legs having been early introduced. Seventy years ago, the ordinary thickness of the boxwood carpenter's rule was not less than a quarter of an inch, but that size has been gradually reduced from time to time in order to give greater flexibility. Many rules have been made of only the sixteenth of an inch in thickness, this small size of wood having to be further cut away to admit of the insertion of the joint, which is inlaid so as to lie level with the surface of the wood. To remove this weakness of the joint, which was the common fault of all thin rules, a joint was produced by Messrs. John Rabone & Son, which being rivetted upon the surface of the boxwood legs instead of any portion of them being cut away to make place for it, adds strength to that part of the rule which had formerly been the weakest. These joints are also enriched by many artistic and ornamental designs stamped upon them, which render the rules, whether regarded for the greatest strength combined with extreme thinness, or for their elegant appearance, appropriately designated by the appellation of "nonpareil." The processes of sawing, rivetting, filing, and planing, are too well known to need reference here; but the numbering and graduation of rules is an operation which, to those unacquainted with it, is generally regarded as the most interesting of the processes. Since the invention of the dividing engine by Ramsden, and its improvement by Troughton, Adie, Reichenbach, Gambey, and others, all the most accurately and finely graduated astronomical and other instruments have been divided and marked by means of it; but the process is much too slow and costly to be employed upon the rules in general use by mechanics. Straight scales and rules are usually divided by placing the article to be divided and the original pattern side by side, then passing a straight-edge with a shoulder fixed at right angles to serve as a guide, along the original, and pausing at each division; then a corresponding line is made on the copy by the dividing knife. Segments of circles are also graduated in the same way, by making a straight-edge revolve on the centre of the circle, and marking off the divisions as on the straight scale. This method, in skilful hands, admits of much accuracy, and was applied to the graduation of theodolites and other instruments prior to the invention of the dividing engine.

About eighty years ago much labour was spent by a Wolverhampton rule maker in the construction of a pair of steel rolls, having upon their surfaces in relief, the various lines, divisions, and figures necessary to impress, at one operation, the two sides of a scale or rule. Its costliness may be guessed at, when it is stated that the scale it was intended to impress contains 2205 lines, divisions, and figures. But the attempt was, as might have been supposed, a failure. Owing to the inequality in the density of the wood, and the slight unevennesses of its surface, the work performed by it was defective, and its use was abandoned. Marking by pressure produces a thick, shallow, and ill-defined line; whereas percussion, when applied to the steel stamps which bear the figures or letters, gives a sharp, clear, deep and lasting impression. The filling up of the marks on the rules is easily effected by simply smearing over them a mixture of oil and charcoal, and wiping the surface clean.

In the year 1858, the late Dr. William Church, of this town, invented and patented a number of machines for the making and graduating of rules. These inventions displayed a vast amount of thought and ingenuity; but he was unaware of what had been done by a few persons in the trade before, and unfortunately for him all that was good and practicable in his inventions had been in use for many years, and his marking apparatus was too complicated ever to remain long in working order. And when it is known that the 540 divisions in the Gunter's line which may be seen on the brass slide of any carpenter's slide rule, are cut singly and accurately by hand in ten minutes by the process above described, it will not be surprising that in this instance manual labour should be cheaper and more to be relied on than machinery, designed as Dr. Church's was, to draw all those divisions at a single operation. In the working of several hundred teeth or cutters all connected together, the blunting or breaking of any one of them would render the work imperfect, and would consume more time in the filing up than the entire process, when performed by the usual method.

The box-wood, of which rules are made, is chiefly grown in Turkey, the English grown box-wood not being of sufficient size and quality. Formerly, large quantities of rules were exported to the United States of America; but, during the past thirty years, they have been manufactured in the States, a prohibitive tariff having prevented the introduction of English made goods. The way in which some nations—or rather—some Governments—regard the importation of rules into their territories is rather strange. Some allow, at fair and equitable rates of duty, the importation of English made rules, the measures being suitable to the use of their respective countries. But while one country will not admit them at all, unless the measure of the country is surrounded by other measures, so as to make the rule a scale of varied measures, instead of being only the legal standard of the country; another Government looks upon all rules, coming to its ports as illegal measures, because they have not the Government stamp upon them, and all so found are seized. The makers do not put a resemblance of the official stamp upon them; and, as there are no native rule makers, and all the rules are imported, measures, a little different from the legal standard are made, and being marked with the name of another country than that for which their use is intended, are allowed to be admitted; thus, the greater part of the people are necessarily using an incorrect measure, at the same time that the true standard might be supplied to them as cheaply and more readily. The various counties and states of the world have, at the present time, about 150 different measures; many small places, each containing only a few thousand inhabitants, have their own peculiar measures. At various times, many of these measures have been changed from the duodecimal to the decimal division, still retaining the original standard of length; but, within the past few years, the use of the French metrical measure has become much more common in all parts of the world. Many nations, now, have a large proportion of their rules marked with the French metre, in addition to their own standard; and are thus, doubtless, gradually tending to the general adoption of so convenient and perfect a measure of length as the French metre is admitted to be.

THE BIRMINGHAM STEEL PEN TRADE.

By SAMUEL TIMMINS, F.R.S.L.

Although the manufacture of Metallic Pens in Birmingham was begun only about five and thirty years ago, the trade has been developed so rapidly, and to so vast an extent, that our town has now become the "pen shop" of the world. The increasing demand for the means of writing, in consequence of the spread of education, and the facilities afforded by the cheap postage system, could scarcely have been supplied by the goose-quills of our grandfathers, and pens could never have been made in sufficient quantities, even by the ingenious "pen machines," which were made extensively in Birmingham sixty years ago.

The maker of the first steel pen may perhaps never be known, but it is believed that the first small supply of the article was made by a Sheffield artisan. The earliest steel pens known appear to have been made of a piece of steel bent into a tubular form, in which the junction of the edges formed the "nib," and the back was cut away into something like the form of the old quill, or the modern "barrel-pen."

Some of the earliest known pens were made in this barrel form, and were highly polished, and sold as high as five shillings each. These, however, were made only in small quantities, as luxuries for presents rather than for constant use, and were known as early as 1809 or 1810. The first development of the trade in its modern form, the manufacture of quantities of pens for a more general sale, cannot be traced further back than 1829. The hand-made pens were then superseded by pens made by the "presses" and other tools so universally used in all the Birmingham trades, and the cost of production was reduced, while the improvement of the article and the uniformity of its shape and quality were secured.

The mechanical genius and perseverance of Mr. Joseph Gillott, whose name has become almost a synonym for a first-class pen, were directed about five-and-forty years ago to the improvement of the manufacture with which his name is associated throughout the world. No skill in manufacture could, however, conquer the prejudices against any metallic pen, and to Mr. James Perry, the promoter of the Perryian System of Education, the world is mainly indebted for the persevering advocacy of the "steel pen," and for one of the most important improvements in its form. Mr. Perry, with his characteristic energy, almost forced the steel pen into use, and was supplied with pens of a first-class quality by Mr. Josiah Mason, of this town, whose name was obscured under the trade name of the "Perryian Pens."*

About the period named, not forty years ago, pens were sold as high as 12*s.* a dozen, and for some years afterwards, wholesale at 20*s.* a gross. A card containing nine was sold retail for 3*s.* 6*d.*, and sometimes even for 5*s.*; and these comparatively high prices were retained till the increasing demand led to the use of better machinery, the reduction of the cost, and the increase of the supply. For some twenty years the trade grew slowly, but metallic pens, or rather steel pens, became more popular, and were found to be equal in flexibility and far more durable than the old-fashioned quill. Scores of improvements were made from time to time by the adoption of side slits, and by the grinding of the surface along and across the pen (in imitation of the scraping process of the pen-knife) to improve the flexibility of the pen, and these improvements are continued to our own day.

When the British Association first met in Birmingham (in 1839) steel pens were almost unknown; but when the second visit was made, in 1849, the steel pen trade had risen to a very important place among the manufactures of our town. Between the two periods named there had been eighteen makers of steel pens, but these had been reduced to twelve in 1849; and although the number is now twelve, the quantity of pens produced has enormously increased.

Although it is difficult to collect any trustworthy statistics of the extent of the steel pen trade in 1849, the following details may be relied on as an approximate estimate of the condition of the trade sixteen years ago—some twenty years after it had been introduced into our town. The number of factories then in operation was 12. The men and boys employed 300, the women and girls 1,550. The amount of horse-power, 228, including 70 as representing out-work rolling. The number of pens made weekly, 65,000 gross. The steel used, 6½ tons per week. The value of the slip or ordinary pens, from 6*d.* to 2*s.* per gross, and of barrel pens, from 8d. to 12*s.* per gross. Some few steel pens were then made in Sheffield and London, but since that time Birmingham has become the great seat of this manufacture, with some few exceptions hereafter to be named.

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* Mr. Stephen Perry has been good enough to inform me that his brother began the manufacture of Steel Pens about the year 1824; that he patented many varieties; that he used the best Sheffield ribbon steel rolled out of wire, and for which he paid 7*s.* per lb.; that he paid 5*s.* per pen to the first person he employed, and that for years afterwards the price given to his workmen was 36*s.* per gross.

As I have been favoured with returns from eight of the twelve firms now engaged in the business, I am fortunately able to give a very trustworthy statement of the present extent of the steel pen trade, suppressing only the details, given in confidence, and giving the aggregate results with so fair an allowance for the firms who have made no return, as really very much to *under*state the actual extent of this most important branch of local trade.

The number of actual makers of steel pens is twelve. The number of men employed, 360. The number of women and girls, 2,050. The amount of horse power employed may be estimated at 330, including say fifty employed in out-work rolling. The number of pens made weekly, 98,000 gross. The quantity of steel used weekly, 9½ to 10 tons. The value of pens per gross, 1½*d.* to 1*s.*, and of barrel-pens from 7*d.* to 12*s.* per gross, some of the larger pens being very much higher according to their size and finish.

It will thus be seen that the trade has greatly increased in the interval of sixteen years, although the protective tariff of France and the war in the United States have seriously checked its progress. It will be seen that the number of persons employed has not increased in the same ratio as the production, in consequence of the many improvements facilitating manufacture, and rendering labour less important. The increase of men and boys from 300 to 360: of women and girls from 1,550 to 2,050: of horse power from 228 to 330: of steel used from 6½ to 10 tons: of pens made from 65,000 to 98,000 gross weekly, will sufficiently indicate the rapid development of the trade during the past sixteen years. These estimates (or rather returns) of the number of persons employed, amounting to 2,400 persons, do *not* include the large numbers employed in making the paper-boxes and other accessories of the trade; and doubtless more than 2,000 persons are more or less directly connected with the steel pen trade in Birmingham alone.

The firms who have kindly answered my enquiries have very naturally declined to give me the annual value of their products, and as I am not connected with the trade my estimate may not be of much value; but taking the very low average of 6*d*. per gross for pens, we may safely conclude that nearly £3,000 worth of pens are made in Birmingham every week. One point relating to the cost of pens is very remarkable, the wonderfully low rate at which they are now produced. Thirty years ago pens were sold wholesale at 5*s*. a gross, and now they are sold as low as 1½*d*. and a 1¾*d*. per gross! When it is remembered that each gross requires 144 pieces of steel to go through at least twelve processes, the fact that 144 pens can be sold for 1½d. is a singular example of the results attainable by the division of labour, and mechanical skill.

Although most of the steel used for pens is produced in Sheffield, all the subsequent processes are carried on in this town, which is now the head-quarters of the steel pen trade. Two new factories had been established in France, in 1849, in consequence of the high duties on English pens; and these factories (now six or seven) produce about 50,000 gross of pens per week, against 16,000 or 18,000 made in 1849. In Germany, there are two factories—producing, however, very few pens. In America, the high war-tariff has caused the establishment of four factories, and these, aided by skilled workmen from England, are producing about 10,000 gross of pens per week. Most of the processes of pen-making are performed by hand-presses, to cut out the blanks, to pierce the hole, to form the nib, to emboss the pattern, and to mark the name; self-acting machinery being used only for the commonest export pens.

The condition of the work-people employed in metallic pen-making is very satisfactory, in consequence of the large and lofty rooms in which the work is usually done, and the generous care which the principal manufacturers display for the welfare and improvement of the persons they employ. The wages of girls vary from 5*s*. to 12*s*.; some of the younger earning only 2*s*. 6d. to 3*s*. 6*d*., while some few of the older and more skilful work-women earn as much as 15*s*. and 20*s*. per week. The men earn from 18*s*. to 20*s*.; the boys, from 4*s*. 6d. to 8*s*., or if skilful, 8*s*. to 16*s*.; and the skilled adult males from 30*s*. to 80*s*., and some even 90*s*. and 100*s*. per week.

The hours of labour are usually from 52½ to 57 hours per week—all beyond these hours being reckoned as "overtime," and the Saturday half-holiday being now nearly universal in the pen-factories of this town.

The varieties of pens made by the various manufacturers may be counted by thousands, being of every degree of size, shape, and finish. One manufacturer only has more than five hundred "marks" made for various buyers who require their own names or devices on the pens. One of the principal manufacturers began by making silver pens for the waistcoat pocket; never dreaming that the article would ever be required by "the million." Mr. Gillott is said once to have made a gross of pens in one day, and for which he received one shilling each; and Mr. Josiah Mason had his attention first drawn to steel pens by seeing a card containing nine marked three shillings and sixpence, in the shop window of Mr. Peart, in Bull-street. Some of the pens for foreign markets are sold as low as three-half-pence per gross; while some of the pens used for lithographic purposes are sold as high as sixpence each. In steel pens, as in every other article of local manufacture, not only can "the million" be supplied from Birmingham with cheap and useful goods, but every variety of article in every form of excellence, can be provided at corresponding rates.

In this brief paper, no description is given of the processes of manufacture, nor of the various improvements made by local industry and skill, the only object being to show how important a branch of local trade the manufacture of steel pens has become, and how its products and importance may be still further increased by the generous treatment of work-people, and the cultivation of their powers, for which our principal steel-pen makers have been deservedly famous during the past twenty years.

THE MISCELLANEOUS TRADES.

[For the materials from which the following papers have been compiled, the Editor is indebted to Messrs. J. B. Browett, C. H. Adames, Gilbert Hamilton, Tangye, J. Clements, W. H. M. Blews, E. Bennett, J. C. Onions, Henry Yates, Alfred A. Atkin, R. F. Martineau, J. R. Boyce, T. P. Salt, and Alfred Driver.]

Tin-Plate Manufacture—The manufacture of Tin goods, at the commencement of the present century, was carried on by small makers in all parts of the kingdom. Even at the largest manufactories in London and Wolverhampton hand-made articles alone were produced, and most of the men employed were little better than half-reclaimed gipsies, who at any time might resume their roving habits.

At that time, and for many years afterwards, so little progress had been made in the manufacture that even so small an article as a patty-pan was made of several pieces of tin-plate soldered together, and the feat of producing one in a single piece, which was not successfully achieved till about thirty years ago, was then justly considered a great event. It was, in fact, the germ of those vast subsequent improvements in the trade which now enable the manufacturer to raise the largest dishes, covers, and basins, or even a good-sized bath, out of a single sheet of metal.

When such was the condition of the manufacture with regard to the simplest article, it may be supposed that so complex a piece of goods as a tin tea-pot presented considerable difficulty. Thirty years ago these utensils were still made entirely by hand, necessarily costly and of the most uncouth shapes. It was not until the discovery of Britannia metal had almost extinguished this branch of the trade that the inventive genius of one who has done so much for the improvement of the manufacture, Mr. T. F. Griffiths, was brought to bear upon this particular department of production. He invented machinery for manufacturing some parts, adapted machinery already used in other trades for the production of other parts, and at last was able to introduce into the market an article which at once commanded an extensive sale, and the demand for which has year by year largely increased.

Within the past four years other improvements have been adopted. Means have been discovered by which a flat sheet of wrought iron can be shaped into a globular form, thus doing away with the necessity of soldered seams in the bodies of the patent teapots, and enabling the manufacturer to produce them with a highly-polished surface in shapes that possess a beauty of outline by no means inferior to that of those manufactured in either Britannia metal or electro-plate.

No block-tin articles have undergone more changes in their mode of manufacture than dish-covers. So long as they were made of pieces of tin-plate, shaped by the workman's hammer, and then grooved together—the universal method of production until quite lately—the inevitable seams prevented either beauty of outline or high finish. Now, stamped from one piece of iron, tinned, wheeled, planished, and polished by improved methods, their silvery colour, beautiful outline, and artistic finish make them formidable rivals to the more expensive and less durable electro-plated and Britannia metal goods. Their not requiring to be cleaned more than once when electroplate would require cleaning six times, is also greatly in their favour. Venison dishes, salmon dishes, soup tureens, and vegetable dishes are made by the same process as the dish covers, and of equal style and finish.

The manufacture of baths, of various kinds, is an important department of the tin-plate trade. They were formerly made of small sheets of metal, most unsightly in appearance and inconvenient in shape. Now, by the aid of powerful stamps and presses, some kinds are made in one piece; and even those that are made in several pieces, by using large sheets of tinned iron, are greatly improved in appearance and utility. The various hydropathic establishments, started at Malvern and elsewhere have, of late years, created a demand for a great variety of baths; and, owing to the general progress of physiological science, the production of these articles has become a large and important trade. In the ornamenting of japanned wares, especially tea-trays, waiters, and other similar articles, a great advance is perceptible. Plain black centres, and simple gold or metal borders, have now almost entirely banished the tasteless and loaded ornamentation formerly in vogue, a result to which Mr. C. Breese's patented invention—only brought into use, for this particular purpose, four years since—has largely contributed. Patterns designed by skilful artists can, by this method, be multiplied to an extent that enables the manufacturer to put on the cheapest articles a style of ornament only used a few years ago upon the most expensive. This valuable invention has not only largely increased the demand for the home trade, but has created a large and increasing demand from foreign countries. It must be admitted, however, that looking at the japanned wares produced by the Japanese, combining beauty of finish with fitness of ornament, there is still plenty of room for further improvement in this branch of our manufactures.

As curiosities of manufacture, vases without seam, or brazing, have been made out of sheets of Bessemer steel; and small octagon bottles, extinguishers, small tubes, and other articles, from flat sheets of iron, to prove the ductility of the metal, and the skill of the workman. Some few other articles connected with this trade are worthy of special notice.

In India, copper utensils have been from time immemorial produced by native workmen by hand labour, assisted by a little rude machinery, such as foot lathes, &c., and at so small a cost from the cheapness of labour that English manufacturers were unable to compete with them until within the last ten years. Owing to the introduction of railways into India, the demand for Indian cotton created by the American war, and other causes, labour has become much dearer. These changes in India, combined with improved modes of raising metals in England, now enable our manufacturers to compete successfully with native produce. For some time past they have been in receipt of orders for copper and brass articles, forming a new branch of trade which promises to become of great value, as, the question of price being overcome, the superior finish of our articles gives them a preference among the native buyers.

The mechanical appliances which have chiefly assisted in developing the trade are the improved stamps and screw and hydraulic presses now employed, and the introduction of "wheeling" in the production of the best turned goods, dish covers, &c. Speaking generally, although some articles of both the highest and lowest qualities are manufactured in Birmingham, the bulk of the trade is in the middle classes of goods. Wolverhampton claims precedence in the manufacture of articles in the most expensive styles, and Dudley in turning out the commonest qualities at the cheapest prices; the main object of the Birmingham manufacturers having been to establish and maintain a high standard of excellence in the ordinary staple productions of the trade.

WROUGHT IRON HOLLOW-WARE, IRON BRAZIERY, AND IRON PLATE WORKING TRADE.—The early metal workers possessed some considerable knowledge of the ductile and malleable properties of iron, and of various methods of joining it by welding or brazing; but it is only within the last century that iron has taken the place of copper or brass for many articles of domestic use.

The liability of wrought, or sheet iron, to oxidise has always put a limit upon the uses it may be applied to. This objection has stimulated manufacturers to invent means of preventing rust by coating the iron with some protecting metal, such as copper, tin, lead, zinc, &c. Of these tin and zinc, applied by immersion, are most used; tin being applied principally to articles intended for cooking purposes; and zinc, especially of late years, to vessels not intended for cooking. Zinc, applied to iron by the process miscalled galvanising, partly decomposes the iron, and forms an amalgam which is exceedingly impervious to oxidisation. This discovery has made possible the substitution of articles made of sheet iron galvanised, for wood, copper, brass, slate, &c., &c., to a vast extent. Galvanised roofing is, of course, well known, and, under certain conditions, is very durable. Galvanised buckets, hardly known twenty-five years ago, are now sold by tens of thousands weekly.

Our extended relations with other countries have secured us, among other good things, a plentiful supply of spelter, or zinc in its rude form. We also use foreign tin; and our hemp and resin come to us from Russia, America, France, and Italy.

Improved methods of stamping, and sundry machines for forming and planishing, have to some extent reduced the cost of production; but the application of machinery generally necessitates some modification of the form of the articles to be operated upon, and, from its not "humouring" the material so much as hand labour, requires a more costly quality of iron.

The exceedingly low price, induced by competition, at which, as a rule, the goods in this trade are sold, together with the singular prejudice existing among consumers against any changes of form, have operated much against the introduction of machinery. From the laborious nature of the work done, not many women are engaged in it, a few only being employed upon the lighter and finishing processes.

Times have changed since the "tinker" was a man known by, and useful to, his fellow villagers only; and our colonists, carrying with them the wants and habits of their native land, spread the demand for our manufactures over the whole world.

The frying-pan, tea kettle, and coal scuttle, are to be found in every cottage as well as in the Royal kitchen. The soldier and sailor look to us for various cooking appliances, as well as for the gabions and buoys which protect them from the rifle bullet, or enable them to moor their ships in safety. Our coffee must be roasted in iron coffee roasters. Our emigrants depend on us for portable ovens, and gold-seekers wash the ore in iron pans. Oil can only be economically stored in iron cisterns. Iron skeps, or servers, deal out food to our sheep and oxen. Sugar boilers and refiners employ iron for many of their utensils. The Indian and the Arab for the concaved sheet and rice bowl that are to represent at once cooking stove, dish, and dinner plate; and which, after use, may be conveniently carried off strapped upon the back. The South American comes to us for huge boiling pots, intended for camp fires, or for "cassava pans," so useful in preparing the various farinaceous food he exports. There is indeed scarcely any part of the world in which our productions may not be found. We even, as a critic at the Exhibition of 1862 observed, ascend to the arts, for we make cattle bells to particular tunes.

The French treaty has not yet been of any benefit to us, prejudice as to form existing largely in France, as here, and goods of similar description being produced cheaply there, though of very inferior quality. The high duties imposed in America have latterly made it nearly impossible to send our goods there at a profit.

"Birmingham and district" produce the bulk of goods coming under this heading; but a good many such articles are made in London, and a lesser number in Liverpool, Bristol, Glasgow, and a few other towns.

Probably more than 2,000 men and boys are employed in Birmingham and district in this trade, whose average earnings would not be less than 25*s.* weekly. Their social condition would be up to the average of the mechanic class, but there is still a serious amount of intemperance among them, and they are very improvident Their homes are sadly wanting in order and general domestic comforts. Much of this should be attributed to the ignorance in such matters of their wives, who are for the most part drawn from factories. There has, however, been some improvement of late, and among the artisans there are not wanting some who afford an admirable example to their fellow-workers.

ENAMELLED IRON.—Enamelling iron with glass by the patented process of Charles Henry Paris, of France, was first introduced into this country in the year 1850, by Messrs. Selby and Johns, in conjunction with Messrs. T. F. Griffiths and Co.

The enamel is a hard silicious glaze or covering formed upon surfaces of wrought or cast iron, so as effectually to prevent any oxidation of the metal. Sea water, salts, and acids produce no effect upon it.

The process was first applied to the coating of culinary articles, such as saucepans, frying pans, baking dishes, &c. It is now applied to wash-hand basins, meat dishes, tea-cups and saucers, dinner plates, &c., &c. These articles, owing to their cleanliness and durability, command a large sale in this country, but by far the greater part of them are manufactured for use on board ship, or for the foreign and colonial markets. A fall or blow may cause the enamel to chip, but the articles themselves are practically indestructible, a most important consideration where the replacement of breakage is difficult and expensive.

Pipes for gas and water service have been enamelled by this process upon a large scale. Upon the first introduction of this enamelled ware, the articles were sold coated grey only, and owing to their dull appearance obtained but a limited sale. In two or three years the white enamel was introduced, giving to the article a more cleanly look, which largely increased the demand. Then followed the printing of the enamelled ware, and shortly afterwards, Mr. Benjamin Baugh largely extended the manufacture by introducing the employment of enamelled iron for door numbers, wagon plates, insurance plates, mill plates, signs, street and index plates, show-cards, door-plates, station-name plates, gradient plates, notice boards, &c., &c., in short, for lettered tablets of every description, as well as for architectural decoration, grate fronts, ship saloons, theatres, &c., &c.

By a recent improvement designs of a most elaborate description are transferred in enamel colours to the surface of the plates, and afterwards burnt in a furnace, and thus secured from the possibility of becoming erased or tarnished by the effect of the atmosphere. Another feature in the recent improvements is the imitation of engraved zinc plates, with such exactness that it requires a careful investigation to discover the difference. Enamel has also been successfully applied to corrugated iron sheets for roofing and small buildings, a purpose to which its capability of resisting the action of the atmosphere admirably adapts it.

Castings and Machinery have long formed an important part of the productions of Birmingham and its immediate neighbourhood. Generally, however, the machinery which a manufacturer requires is made in the manufactory itself, and the details of such machinery are rarely disclosed. Still, Birmingham produces large quantities of machinery for export and home use; and although steam engines were first introduced by the famous firm at Soho, they have not till recently formed a very important part of the productions of the town. The early steam engines, or "fire engines" as they were called, were supplied for pumping purposes to Cornish mines; and the fame and value of a Boulton and Watt engine has long remained unchanged, the engines being still supplied by the representative of the original firm retain a position unshaken by all the competition of our time. The Soho Foundry, established in 1797 to furnish the castings which the parent establishment at Soho required, is still continued by the firm of James Watt & Co., and produces all kinds of engines for pumping water, blowing furnaces, driving machinery, and propelling steam vessels. Marine and land boilers, mill gearing, sugar mills, coining machinery, apparatus for pneumatic railways, and for sewerage works, are also largely supplied—the latest examples being for Rio de Janeiro, and the Metropolitan Sewage Works at Crossness. The works cover an area of ten acres, and since 1775 have produced 1,878 steam engines, having a *nominal* power of 70,958 horses, and equal to the actual force of 250,000 horses. These consisted of 319 pumping engines, representing 13,800 horses; 1,090 rotative engines for manufacturing purposes, 25,986 horses; 469 marine engines equivalent to 31,169 horses, making the total given above. Of these the largest were those of the Great Eastern to work the screw propeller, and having four cylinders of the united power of nearly 1,700 horses, but capable of an actual force of more than five times that amount. The early reputation of Soho has thus been not only maintained, but extended by the works which bore till recently the honoured names of "Boulton, Watt, & Co."—the name of Boulton being removed in 1848, after the death of M. R. Boulton, Esq.; the firm now bearing the title of "James Watt & Co.," and producing besides its coining machinery a vast quantity of coins, as shown in a previous page.

The manufacture of steam engines has been carried on by many other firms; and those adapted for agricultural purposes, small steamers, portable uses, &c., have been very largely and successfully produced by the firm of Belliss & Co., founded by Mr. Richard Bach. Messrs. Walter May & Co. have also produced large quantities of agricultural engines and machinery, for which during the last ten years there has been a very large demand. Although Birmingham is not generally supposed to be a machine-making town, when compared with Manchester, a full enquiry would show that an enormous number of machines for very varied purposes are constantly produced for the home as well as the foreign and colonial trade. Ironfoundry has long been, and still is, one of the staple trades of the town; and although it has been impossible to collect the statistics from so large an area, the quantity of castings produced reaches many thousands of tons every year, including castings varying from a few pounds to many tons in weight; chilled and other rolls, used in local works; and heavier castings for the Exhibition Building in 1851, and the Sydenham Palace, both produced at the London Works.

MALLEABLE IRON CASTINGS form one of the most valuable, if not one of the most extensive trades of the town, and supply every branch of trade in which iron is required, and in cases where formerly only wrought iron or forged work was used. These malleable iron castings were first developed in Birmingham about 1811, and were chiefly used for coach harness and snuffer work. Although so vast an addition to all modern trades, the process is scarcely mentioned in any scientific books. Wherever a comparatively light article of complex form is wanted, the malleable casting process furnishes all that is required. When the mould is once made by the "pattern" which is provided, any quantities of the articles may be cast and rendered malleable by a simple process of "annealing." The popular prejudice that these articles are but cast iron after all, is quite unfounded, since if well annealed they become nearly pure iron. The best quality of Cumberland ore is required, and is obtained chiefly from Ulverstone. The pigs are melted, and the liquid iron is run into the moulds, whose forms it fills. It is, when cool, as hard and as brittle as glass, but when placed in pots, surrounded by powdered ore obtained from the same sources, and subjected to a certain heat for a certain time, the iron is, by a process of "cementation," rendered malleable down to its very core, if the process be continued for a sufficient time. After reaching a certain heat, and undergoing certain chemical changes which need not be described, it may be made almost as soft as lead, and may be bent or worked into any shape required. The process, which has been modified by many patents, was first practically used by Samuel Lucas, of Dronfield, near Sheffield, who, in 1811-12, entered an action at Derby against William Grove, of Birmingham, who had begun to apply the annealing process on a rather extensive scale to the casting of coach-harness work, snuffers, and other light iron work. At the trial at Derby, the Birmingham castings were shown to be far superior to any previously produced, and the local trade rapidly grew to its present enormous extent. Castings for snuffers, originally sold at 10*d.* a pound, have been reduced to 5*d.*, but the demand has decreased with the more general use of lamps and gas. Scarcely a trade in Birmingham fails to use some of the malleable iron castings, which are equal to wrought iron for all ordinary purposes. No cutting edge can be maintained on malleable iron, but the process has been largely used in Sheffield for scissors and similar purposes under the name of "cast metal." For the cheaper sorts of gun furniture for foreign markets, for nearly every article which is complex in form and troublesome to make, "malleable iron" is constantly used. One caster, one of the oldest in the trade—Mr. Thomas Cardall—has made during the last thirty years nearly 3,000 different patterns of stirrups, most of which are still in demand when trade is good; 4,000 or 5,000 sorts of keys for famous locks; thousands of copying presses often sold as "wrought iron," and many tons of the many thousands of patterns supplied by various manufacturing firms. As much as 15 cwt. of stirrups and one ton of small keys have been cast in one week; and the malleable casters of Birmingham now produce not less than 10 tons of various articles per week. Although only about fifty casters are employed, producing about 4 cwt. each per week, the number of small articles produced is enormous, and the castings for machinery in Sheffield and Manchester are on a vast scale. The casters are paid 7*s.* or 8*s.* per cwt., and earn about 30*s.* or 32*s.* per week, and women are employed only in assorting and weighing the work, which is usually sold at about 3½*d.* or 4*d.* per lb. The Lucas patent of 1804 is still used almost unchanged. The annealing process takes about ten days. A pot made up on Tuesday is got up to a white heat about Friday, and this heat is maintained for about twenty-four hours, according to the size or thickness of the articles to be annealed. On Saturday the fire is allowed to die down, and when the mass is cool the castings are found to be thoroughly annealed and malleable. No pyrometer or other means are used to judge of the result; but doubtless science will be able soon to shorten the process and to render "malleable castings" more readily attainable than now.

HYDRAULIC MACHINERY.—The development of this department of manufacture is principally, indeed almost exclusively, due to Messrs. Tangye Bros. and Price, of the Cornwall Works, Soho, established in 1855. About 260 men and boys are employed in it; and, although the individual articles are of no great weight, 700 tons of machine castings are consumed annually in their production. Hydraulic jacks had been occasionally made before 1855; but the manufacture, up to that time, had not been conducted on an extensive scale. One of the first large orders executed at the Cornwall Works was for the jacks, or "hydraulics," employed in launching the "Great Eastern" steamship. Since that time, there have been produced at the works upwards of 1,200 hydraulic lifts, 600 hydraulic presses for cotton and wool, and a large number of hydraulic machines for punching and shearing, testing girders, chains, steam-boilers, metal-tubes, &c. The principle in all these various appliances is the same, the multiplication of the workman's strength by the intervention of the hydraulic pump and ram. Bramah's press was constructed on the same principle, but the range and mode of its application have been greatly extended. In some of the smaller lifting jacks, easily worked by a child, the valves are not more than one-sixteenth of an inch in diameter, while, in a hydraulic shearing machine, made here for the Russian Government in 1863, the weight was 24 tons; and the pressure to be exerted on a sixteen-inch ram, 1,000 tons—a force sufficient to cut in two a bar of iron six inches square. One form of press is adapted for stamping palates and mouth-plates for dentists' use;

another moulds and ejects a continuous stream of black-lead for pencil-making. In these, and the various other forms of hydraulic presses, construction is simplified by placing the pump within the water-tank, and placing both in direct connection with the body of the press, instead of separately, which would involve the necessity of pipes and joints.

Another specialty of the Cornwall Works is the manufacture of Weston's differential pulley-blocks, first made here in 1859; and of which about 25,000 pair have since been produced. These are the only pulley-blocks yet made in which the weight is supported without risk of running down, while the cord or chain is hanging loosely. The multiplication of power, also, can be carried to almost any extent with an exceedingly small amount of friction. These blocks, besides their extensive use in warehouses and manufactories, have found several special applications. While recovering from his recent illness, the King of the Belgians was accustomed to ascend from one floor of his palace to another by means of these blocks, a suspended couch being provided, from which his Majesty, with very slight exertion, could raise or lower himself at pleasure. In a note to the inventor, General Garibaldi recommends their use for remounting artillery thrown down on the battle-field. The watchman at the lofty fire-observatory at Hodges's Distillery, in London, raises himself easily and rapidly to a height of 135 feet. At an *abattoir*, near Brussels, 120 pairs are used in hoisting and hanging the carcases of the slaughtered beasts. Prince Napoleon, in person, purchased a pair at the Battersea Royal Agricultural Show, for use on board his yacht. In Borneo, they are attached to trees overhanging the coast, for loading vessels. They are also largely used in the Cornish mines. They suspend heavy chandeliers in public halls, &c. They are fitted on board the Royal Oak and other iron-clad steamers. They lift the tops off wagonettes in coach-houses. In short, whereever lifts are required with complete security in raising and lowering, the differential pulley-blocks are employed with advantage.

More recently, large hydraulic machines have been made for testing chain-cables, iron bars, &c. They are fitted with the weighing levers required by the Board of Trade in testing ships' anchors, &c.

Two-thirds of the whole value of the manufactures of these works are exported, and the French trade, owing to the operation of the Treaty, has increased from a few hundreds per annum to £12,000. The average wages of skilled hands are 55*s.* per week. Second-rate hands earn from 30*s.* to 40*s.*

SEWING MACHINES, either complete or in parts to be made up elsewhere, are made in large quantities in this town, and a Birmingham machinist was the first to perfect the American invention by providing a continuous instead of intermittent "feed." Within the last twelve years Birmingham has produced more than 30,000 sewing machines, besides the small fittings for nearly all the machines made in England. More than 100 are made every week, and one manufacturer sends out from 2½ to 3 tons of castings every week. Although applications for forty or fifty improvements in sewing machines are made every year, Birmingham is employed in making rather than improving; but Mr. Clements has recently perfected an ingenious machine by which even button holes can be properly and rapidly stitched.

NAIL MAKING MACHINERY for fluted nails, and PERCUSSION CAP MAKING machinery for cutting the copper and making the caps at the rate of 250,000 to 300,000 per day have been invented, patented, and manufactured by Mr. John Abraham recently, and are much in demand. PNEUMATIC or ATMOSPHERIC HAMMERS have also been introduced by Messrs. Phillips; Whitfield and Co.; and Vaughan Brothers, for various manufacturing processes, but the details cannot be given here.

SWORDS.—Sword cutlery appears to have been made in Birmingham at a very early period, but it is not till Charles the First's time, when 15,000 swords were supplied to the Parliamentary army, that there is any distinct evidence of the manufacture being carried on here. The first order executed directly for the Government was given to Mr. Dawes, of Snow Hill, and Mr. Hervey, apparently towards the close of the last century. The processes employed are nearly similar to those in the ordinary heavy edge tool manufacture, so far as the production of blades is concerned. These are made from steel bars, cut into lengths called moulds, there being sufficient steel in each mould to make two blades The flutes or creases are produced by "swages" of the necessary shape. If the blade is curved, it is then bent and fitted to a gauge, hardened and tempered. The temper is tested by striking the blade on the back and edge of a wood-block, and afterwards bending it into a semicircle. It is then ground on large stones, "bobbed" on bobs fitting into the grooves, flutes, &c.; "glazed," and finally polished on another bob with fine emery and oil, powdered crocus or iron-stone being used for the brilliant polish. The "blueing" of ornamental swords is effected by heating on sand, gilding by the ordinary amalgam process, etching, Damascening, &c., as in other manufactures.

Sheaths are made by bending thin plates of steel round suitably-formed mandrils or templates. They are soldered with hard solder, and ground and polished in the ordinary way.

Bayonets, sword-bayonets, cutlasses, &c., are also manufactured in Birmingham; but matchetts, sugar-cane knives, &c., &c., have to some extent given a pacific turn to the sword-cutlery manufacture.

The principal manufacturers are Mr. C. Reeves, at the Charlotte Street Works, and Messrs. R. Mole and Son, in Broad Street.

BELL-FOUNDING.—During the middle ages, it was a harder matter to carry a large bell any considerable distance, than to cast it in the immediate neighbourhood of the church or cathedral tower in which it was to be erected. Even so late as 1762, the great clock-bell at Canterbury was re-cast in the cathedral yard. The principal works of the mediæval bell-founders were in consequence produced by craftsmen travelling from place to place, and the manufacture had no great settled centres of production. That these craftsmen were cunning in their craft is still proclaimed Sunday after Sunday, from half the belfries in the land. One law of nature, indeed, they were acquainted with, which modern bell-founders for the most part ignore so long as their bells are paid for,—that a given weight of bell-metal can only sound a very narrow range of notes with good effect, and that if bells are cast thinner to produce deeper notes, the quality of tone must suffer.

Bell-metal is compounded of three parts copper to one of tin, this proportion giving the greatest density of metal. The true chemical combination, however, would be six atoms of copper to one of tin, or in weight three and a quarter to one. The best proportions for the shape of a bell are, perhaps,—taking the thickness of the sound-bow or brim where the clapper strikes, as the unit;—diameter at mouth fifteen brims, height to shoulder, twelve brims, width at shoulder seven and a half brims.

There are two ways of making moulds for bells, the core in both cases being made of a brick-work or cast-iron cone, covered with moulding-clay, "swept" into the shape of the inside of the bell by a wooden "sweep" or "crook" fixed to a spindle set up in the middle of the core; the advantage of an iron core being that it can be lifted into a furnace to dry, instead of being dried by lighting a fire inside it, as is necessary in the case of the brick-work core. The first, or old method, is to make a clay bell on the core by means of another crook, and when this is dry, to make the outside mould or "cope" on the top of it. This cope has hair and hay-bands, or in large castings, iron bands worked into it to make it hold together, and lift off when dry. The clay bell or "thickness" is then knocked to pieces, the cope dropped down again over the core and weighted with earth in the pit in which the bell is cast. The metal is then poured in at one hole at the top, another hole being left for the air to escape. In the other method, no "thickness" is made. The cope is an iron case, lined with clay, and swept out by an internal sweep to the shape of the outside of the bell. The "wires," or ornamental rings round the bell are made in both cases by the second sweep, the letters, ornaments, &c., being stamped in the soft clay. These iron copes can be bolted down to a plate under the core, and consequently need not be sunk so deep in the ground, provided only that care is taken to get a high enough "head" of metal above the bell, to ensure a good quality of metal in the upper part of the bell.

Bell-founding seems to have been unknown in Birmingham till the middle of the last century, when a foundry was in existence opposite the "Swan" at Good Knave's End, on the road to Harborne. This foundry supplied peals of bells to three adjoining parish churches in 1760. Twenty years later, one Ducker had a foundry at Holloway Head, and cast chimes, since which time there is no record of large church bells in peals having been cast in the town, although an extensive trade in other descriptions has continued to flourish and extend.

Church, school, plantation, factory, and ship bells, still closely adhere to the mediæval type. They vary in size from half a hundred-weight to half a ton, the largest size now cast in Birmingham. There is a great demand for them in the home and nearly every foreign market, including South America and the Colonies.

Railway and dinner bells, from four to seven inches wide at the mouth, with a wooden handle attached, are largely used for domestic purposes; and the majority of railways in England, India, Russia, Brazil, &c., have been supplied from Birmingham.

Musical hand-bells are still made, but the demand is very limited as they are seldom required by any but village ringing clubs. Cattle and horse bells are oblong at the mouth, the size varying from three-and-a-half inches by two-and-a-half inches, to seven inches by three-and-a-half inches. They have conical sides and a square iron loop at the top. They are in great demand for Australia and New Zealand, the smaller sizes being suited to the Brazilian and South American markets.

Sheep bells are circular at the mouth, and an elongated semi-circle in shape, with a loop at the crown. They are used in England, and exported to the Cape, Australia, New Zealand, &c.

House bells are so familiar as to need no description. Some exceedingly small bells, from ¾ to 1½ inch, are used as an article of barter in the African trade. Sleigh, dray, and caparison bells, small circular bells, with an iron ball cast inside, are largely used in Canada and India, and command a limited sale at home. During the last ten years an increasing demand has arisen for fancy, table, office, and call bells, constructed of the ordinary clock-bell, mounted on a stand, and struck by the pressure of a spring.

Not very long since, Messrs. Scholefield, Sons, and Goodman executed an order for 10,000 green bronzed and lacquered house bells, 12oz. in weight, for a West African Prince, to adorn his new iron palace. Messrs. J. Wilson Browne, and Co. recently also received an order from another African prince for a number of polished ship bells, in elegant brass frames, and mounted on mahogany stands, some of which were engraved with the name assumed by the distinguished potentate, "Yellow Duke, Esq."

The number of hands employed in the various branches of the manufacture is about 200, casters earning from 40*s*. to 60*s*., dressers and finishers 28*s*. to 36*s*. per week.

Messrs. William Blews and Sons, whose firm has been established nearly a century, have recently erected a foundry, which enables them to supply church bells of a large size and in chimes.

ROASTING JACKS.—After the primeval human "Jack" had been exempted from the labour of rotating his master's beef and mutton before the kitchen fire, his place was taken by the canine "turn-spit," who worked in a round cage or treadmill which communicated its motion to the spit. The next advance was to the use of a machine. Weights were suspended outside the house, attached to a wheel with slanting teeth, working in an upright spiral pinion upon which a fly-wheel was fixed. A few jacks of this kind are still in use, but require much attention. Smoke-jacks were next introduced, and are still in common use, although the first outlay is considerable, and constant attention required to cleanse them from soot. About thirty-five years ago, Mr. Pearse, of Tavistock, invented his "veruvolver" jack, worked by a spring, and the same principle was adopted with slight modifications in the Linwood veruvolver. The spring employed is 12 feet long, by 2¼ inch wide; great motive power being required to overcome the friction of the bearings of a horizontal spit. Fitted to a screen, these jacks form a compact, and when carefully used, an efficient roasting apparatus. This principle has been applied to coffee-roasting.

Vertical jacks, suggested, doubtless by the string previously employed in roasting, have not probably been in use more than a century. A workman now living remembers a friend who worked at smoke-jacks for Lane, in Bell-street, lamenting their introduction as likely to prove fatal to his own trade.

The first Birmingham bottle-jack maker was Mr. Fellowes, in Great Hampton street, who commenced the manufacture about seventy years ago, and painted his gates with illustrations of the use of his jacks. Mr. John Linwood commenced business shortly afterwards, and about 1800 devised considerable improvements in the internal arrangement of the works. His successors (Messrs. E. B. Bennett and Co.) still use his name and trade-mark on their goods.

The ordinary mechanism of the jack is as follows:—A spring, on being wound up, turns the main wheel in which a pinion works with an escapement-wheel attached. The nine teeth of this wheel are of a saw shape, and work alternately in the upper and lower palette of a verge, placed perpendicularly. To the verge, a quadrant, cut with teeth, is affixed, working a pinion with a small wheel. This wheel acts on the centre pinion, which is suspended on the best silk procurable, and keeps it twisting and untwisting for from two to four hours, according to the weight appended.

Many new inventions have been introduced, of late years, but all retain the feature of the silk suspended. Chesterman, of Sheffield, about thirty years since, brought out his "lever" roasting-jack, in which the escapement is effected by pegs rivetted in two wheels, of the same size, working into each other, which alternately strike against each side of the quadrant, the rest being similar to the ordinary bottle-jack, except that the works are so placed as to have the key at the top of the case.

The "horizontal" jack, of Shaw, of Birmingham, and the pendulum-escapement jack, of Messrs. Gray and Bailey, need no description, as their use has been abandoned.

Restell's patent is perhaps the most successful modification of the original bottle-jack. In shape, it somewhat resembles a barometer. The escapement is effected by a crown-wheel, toothed on one-half the outer edge, which works a double-headed pinion one way in descending, and the reverse in ascending. To this pinion is attached a wheel, communicating the required action to the silk line.

The "tripod" jack, so called from the shape of the case, was patented by Nicholas, of Birmingham. The neck-tube is used as the axis of the main-wheel, an intermediate one connecting it with the escapement-wheel, which has two quarters of its circle of teeth removed, alternately engaging two pinions connected together by two equal-sized wheels, so that when the toothed part of the escapement-wheel is in gear with one pinion, the blank part is passing the other, thus giving to each an alternating rotatory motion, conveyed to the line by a larger wheel attached to one of the pinions. The centre pinion is formed of a loose head, working on square wire, thus remedying the inconvenience of a slack line, as the head of the pinion always remains in its original position.

Water-jacks have been tried, but with little success. A weight is attached to a round barrel about 6 in. deep and 12 in. in diameter, divided into four compartments. Between each of these compartments is a small aperture through which the water drips, and as each chamber empties itself into the succeeding one, it gradually revolves, the weight acting as the motive power.

Hot-air-jacks have been tried on the smoke-jack principle, but can only be used with the ranges to which they are fixed.

Since 1849 the manufacture has increased about 35 per cent. Silk, an important article of raw material, has greatly advanced in price since that time. Machinery is employed in cutting the wheels and pinions, but the fitting is all done by hand. Women are not employed. Boys from twelve years old and upwards are gradually initiated into the several branches of the trade, those brought up to it being generally the best workmen.

Jacks are now sold at less than half the price originally charged by Mr. Linwood, although only gradual reductions have taken place in the last thirty years. Cheap jacks have lately been introduced in which cast iron takes the place of brass, but have not been generally adopted.

About 40,000 jacks are manufactured annually in Birmingham and the neighbourhood, principally for the home trade. A few are exported to America and Australia, but scarcely any to the continent, where roasting is differently conducted. Some, constructed to continue in action for twelve hours with once winding up, have lately been exported for the exhibition of goods in shop windows.

Bottle-jacks are made in London, but not in large numbers. Smoke-jacks are there made to a large extent, and are in demand for many of the large club houses, &c.

Probably not more than 150 men and boys are employed in the trade. Wages vary in the different branches, but skilful workmen command a high rate of remuneration.

THE BELLOWS TRADE.—The demand for bellows in and around Birmingham, and the plentiful supply of iron, wood, and leather existing in the neighbourhood, have combined to confer on the town almost a monopoly of this manufacture. Its early history is unknown, but in 1650 it was already extensively carried on by an enterprising handicraftsman named Onions, whose lineal descendants have from that day to this ably maintained the reputation of their ancestor. Until comparatively very late years, the manufacture was confined to household and smiths' bellows of the conventional type, the late Mr. John Collingwood Onions, father of the gentleman at present bearing the name, having been among the first to introduce any important novelties. The steam circular, vertical, and band-saws, the application of machinery to nail-making, and the improvement in the art of tanning leather, by which bark has been superseded and skins can be prepared for drying in a few days instead of months, have all immensely augmented the appliances at the command of the bellows-manufacturer. The patent fan-forge, in which the blast is produced by a rotatory fan, set in motion by a small handle turning a wheel connected with other wheels by leather bands, was perfected by Mr. Onions a few years ago. The patent smiths' bellows also, with a removable pipe capable of being inserted with the nozzle reversed into the aperture over which it fits when in use, so as to lessen the bulk and reduce the risk in transmission by road, rail, or water, was another of his inventions. Bellows are employed, however, for other purposes than those of the household hearth and smithy. An army on the march in Canada, India, or Australia, carries with it not only the portable forge on wheels in the artillery train, but horse-forges and pontoon-bellows for inflating pontoon-bridges. At home, too, no inconsiderable demand exists for library bellows, and air-bed and cushion bellows. In the manufacture of these fancy bellows a few women and girls are employed in "dressing," *i.e.*, making and adjusting the "quilt" or interwoven leather hinges on the upper side above the pipe. Boys are employed in directing machines and closing and finishing small bellows, but in all the heavy work men exclusively are employed. Both for fancy bellows and the more ponderous articles employed by the smith and metallurgist, Mr. Onions received a medal from the Royal Commissioners of the 1851 Exhibition. In 1853 he presented to the French Emperor a pair of bellows, the covers of which were carved from the willow that overshadowed the grave of the First Napoleon, and the elm from which the local authorities of Stratford-on-Avon commenced their annual perambulation of the parish. For this present Mr. Onions received a gold medal and the appointment of bellows-maker to the French Court. He is also bellows-maker to Her Majesty's Board of Ordnance. From his establishment in Bradford Street are sent out weekly about 30 forge-bellows, 100 smiths'-bellows, and 260 dozen house-bellows. Of these about one-fourth are for the home and the rest for the foreign trade. About 100 men are employed, in-door and out-door, whose wages average about 26*s.* per week. The wages of the boys and women vary according to their age and occupation.

Heavy Edge Tools.—Owing to the suicidal activity of the Sheffield Trades' Unions, by far the greater part of this manufacture is now located in Birmingham. Some idea of its extent and variety may be formed from an enumeration of the principal articles manufactured. Axes, solid, and steel-blued—American, Columbian, Hondurian, Brazilian, Spanish, &c. Adzes, bills, hatchets, butchers' cleavers, hoes, grubbing hoes, garden hoes, turnip hoes, cotton hoes—Carolina, Demarara, West India, Columbia, Boston, Portuguese, Spanish, Mamottee, East Indian, Egyptian, &c. Shovels, gravel shovels, Spanish and Biscayan shovels, spades, socket spades, London spades, Scotch spades, &c.; soughing tools, draining tools, pick-axes, wedges, ploughs, crowbars, garden and hay forks and rakes, Augers, tap-borers, firmer and socket chisels and gouges, plane irons, mincing knives, drawing knives, chaff knives, ship-scrapers, caulking irons and trowels—each and all in almost endless varieties, nearly, if not quite, three thousand differently shaped tools being made in Birmingham and the neighbourhood. Every nation has some peculiar shape for its axes, hoes, &c.; and there is no hope of getting into the market unless this shape is imitated. Unfortunately, in former days, manufacturers seemed to think that an imitation of the shape was all that was necessary, and were in the habit of sending out goods in which the only steel used was on the face of the hammer with which they were planished or forged. This evil, however, has to a great extent wrought its own cure, inasmuch as in the long run the demand for an article that does not fulfil its purpose is certain to cease.

Great improvements have taken place in the manufacture, consequent on the introduction of machinery for hand labour of late years. Among the appliances that have most facilitated production, are:—

The "tilt-hammer;" an immense cast-iron hammer, worked by steam and striking from about 75 up to 400 blows on the anvil in a minute.

The "squeezer;" a hinged press, consisting of two powerful jaws of which the upper is moveable, and the lower, which forms the anvil, fixed. The working jaw, set in action by a crank, makes from 50 to 60 motions in a minute.

The "shears;" one blade of which is bolted to a massive fixed frame, the other to a powerful lever hinging on an axle, and attached at the lever end to a connecting-rod moved by a crank. These gigantic scissors will cut iron ¾ inch thick, by 3 inch wide, with the greatest ease.

The "rollers;" identical with the laminating rollers of the sheet-iron rolling mills.

The various processes employed differ to some extent in almost every article manufactured. An account of the usual method of making a hatchet will be sufficient to give an idea of those ordinarily practised. The long bar of iron out of which they are made is cut into lengths called moulds, by the shears. One of these moulds is heated to bright redness, and a piece of steel welded on to the central part to form the poll of the hatchet. One half the length of the mould on each side of this central part is then thinned and drawn out sideways into projections, after which, the work is folded at the central part round a tapering mandril of the section of the intended eye, and welded across the line of demarcation between the extended portions and the untouched tails. The tapering mandril is then again introduced into the hole from both sides, so that the handle, when fitted and wedged in, will hold it firmly. A slip of best cast steel is then inserted between the tails, as yet of their original size, up to the first weld; and all three are welded to the proper extent. The work is then put into a hollow fire and the combined iron and steel drawn out sideways to the required width under the tilt-hammer. The hatchet is then flattened and smoothed with the hammer; the edges are pared with the shears, and trimmed with a round-faced hammer or top-faller, the parings being afterwards sent to the gun-barrel makers'. After being ground on Derbyshire or Yorkshire stones, it is glazed on a "bob," or wooden wheel covered with leather charged with emery. If not intended to be ground all bright, the part left unground is generally blued or black japanned. It is then "treed up" by the insertion of the helve or handle.

For the handles of tools 1½in. ash-wood planks are sawn into shape by a circular saw, and the rough shapes turned in lathes, self-acting lathes being employed in the largest manufactories. "Crutch-tree" handles are made in two pieces, the crutch being put on to the top of the handle. "Eye-tree" handles are cut out with a broader part at top, in which a small hole is bored by a revolving gouging tool, and the eye cut out with a small steam saw. Bent handles for spades, &c., are boiled and put into the bending machine in which they are screwed into the required shape, the screws being worked by hand.

The Germans are the principal foreign European competitors in this business, but in order to sell their wares they are obliged to forge the names and marks of established English houses. The French treaty has not as yet done much for the Birmingham trade. The failure of the cotton-supply from the Southern States of America during the war, led to the establishment of cotton plantations elsewhere, in India, Egypt, &c., and the demand for plantation-hoes has consequently enormously increased, far more than exceeding the American demand in its palmiest days. The Gloucestershire manufacture of these tools was formerly most extensive, but Sheffield and Birmingham gradually absorbed the greater part of the trade, and, at the present time, Birmingham and the Black-country towns are the principal seats. About thirty works are in existence, employing, it is estimated, about 3,500 workmen. Each "foreman" employs an "underhand" or "striker," who receives one-third of the wages; thus if the "foreman" earned £3 per week, the striker would receive £1, and a good workman will make about this sum on an average. Boys receive from 8s. to 15s. per week, according to age. Women are rarely employed in any but warehouse operations, wrapping, &c. The social condition of the workpeople has decidedly improved, drunkenness having perceptibly diminished, and education progressed. Among the principal manufacturers are Messrs. John Yates and Sons, of the Exchange Works, Aston, and Pritchett-street, who employs about 400 hands, the great bulk of the goods made being for foreign and colonial markets.

Saw Manufacture.—Sheffield has long been the chief seat of this trade, but it is now an important industry in Birmingham. The processes are in all cases nearly as follows:—Steel of the best quality for the purpose is cast into ingots and rolled into sheets, from which the saw-plates are cut by a paring machine. The "toother" then cuts the teeth by means of a punch worked by steam-power, each space between the teeth being separately punched out. The saw is then marked and filed, and subsequently hardened by heating and plunging into oil. The brittle temper thus produced is afterwards brought down to the degree of hardness and elasticity required. It is then hammered, great skill and judgment being required to level the uneven surface left by hardening. Machinery has been tried for this purpose with very limited success. Grinding is the next process, on stones from 5ft. to 6ft. diameter. After shaping the back the grinder places the saw on the "scorching" board, and brings it across the grindstone, placing his knees on one edge and his hands on the other of the board, the saw being worked across the stone from edge to back, and from heel to point. When "scorched" or ground on both sides crossways, the saw is "drawn" or ground lengthways, straight saws being ground thinner at the back. It is then hammered, to correct any irregularity that may have arisen in grinding, stiffened or tempered over a coke fire till it assumes a straw colour, to give it elasticity, polished, and rubbed, this last being now generally done by a machine, which obviates the necessity for the laborious and unhealthy process of rubbing by hand, which used to be done by women. If the saw be a short one the setter and sharper sets the teeth alternately with a hammer, and sharpens them with a file, when it is ready for the handle.

Grinding straight saws by machinery is now practised successfully in Birmingham, and is a great boon to the workman, who is now not obliged to stand so immediately over the stones. The tendency of Trades' Unions, however, to check any improvements has prevented this process (invented by Messrs. Atkin and Sons) being generally adopted, in spite of the labour and unwholesomeness of the old method.

Most of the work is executed by men and boys, a limited number of women being employed in rubbing, etching ships, coats of arms, railway trains, and other designs on the saws, wrapping up, and polishing the handles.

The principal kinds of saw are the "cross-cut" saw for felling timber, afterwards to be cut into boards by the "pit-saw," the "frame-saw," or the "logmill-saw." The carpenter afterwards employs the "hand-saw," the "panel" and "ripping" saw, the "tenor," "sash," "dovetail," "table," "lock," "keyhole," and "turning" saw, the last used in a tightly-stretched frame for cutting circles, sweeps, and other fret work. The "logmill-saw" is said to have been first employed in Madeira, in 1420, and three years later at Breslau. For a sawing mill, the saws are fixed in a frame, sometimes to the number of forty in one frame, and are moved up and down by steam or water power, the wood being drawn up to the saws and cut into planks. The circular saw is a disc, of from one inch up to ninety inches in diameter, with teeth at the edges, made to rotate in a frame. From six to eight thousand superficial feet of 11-inch deals can be sawn by it in one day by one man. The circular saw was little used before the present century, but has since become the most important article in the trade, being employed by the timber-merchant, ship-builder, builder, joiner, agriculturist, iron-worker, and brass-founder. They are driven at a speed of from 100 to 2,000 revolutions a minute, according to the work. Messrs. Atkin and Sons employ a patent process for grinding circular saws, which ensures a uniform thickness throughout the periphery, a point of the utmost importance to prevent the saw shaking in its bearings. The saw is made to revolve on its own axis, and to pass between the outer diameters of two large grindstones revolving at great speed, all irregularities being thus removed. The "bevelled" or ground-off circular saw, lately much used for cutting pine deals, is made very thick in the body to obtain strength, the outer edge being ground taper for six or eight inches, till no thicker than a handsaw, much wood being thus saved, as from twenty to twenty-four boards can be cut in a 3-inch deal.

Veneer-saws, for cutting rosewood, maple, walnut, satin-wood, knotted oak, &c., into thin broad slices, are made from five to thirty feet in diameter, in segments, six to twelve inches wide, very accurately fitted on a foundation wheel, to the outer edge of which they are attached by screws. From twelve to eighteen slices are cut by these saws out of wood an inch thick.

The latest novelty is the band or ribbon-saw, formed of a long thin web of steel, united at the ends, or rolled in one piece from a steel ring. This web, toothed on one of its edges, is passed over two pulleys which are put in rapid motion, the descending part of the web passing through a table on which the wood to be sawn is placed. The defect of this saw is its liability to breakage.

The class of article produced in Birmingham is the very best. Both saws and other tools are made chiefly for the home trade and Indian and colonial markets. The steel for saws is largely exported to the United States, but the tariff prevents the importation of the finished articles. An increased demand from France, since the passing of the Treaty has, however, to some extent, counterbalanced the falling-off in the American trade. The smaller kinds of wares, web-saws, frame-saws, band-saws, &c., are now largely made in France and Germany.

The earnings of the workmen are from 30*s*. to 40*s*. per week, according to their skill. Their social condition is good, partly, perhaps, owing to their having no connection with trades' unions, the bane of Sheffield.

Planes.—These well-known tools need no general description. Under the head of "flat" or "bench" planes, come the "jack," "trying," "smoothing," "panel," "compass," "smooth," "toothing," "jointer," "cooper's-jointer," planes, &c., &c. Moulding-planes for columns, wainscots, door-jambs, cornices, &c., include the "astragal and hollow," "bead," "cove and bead," "cornice," "moving" and "sash-filister," "grooving and dado," "hollow and round," "necking and nosing," "Grecian ovolo," "ogee," "plough," "reed," and "rebate" planes, &c., &c., all including hundreds of varieties. The manufacture has been carried on in Birmingham for upwards of a century, one William Moss and his descendants having been in the trade from 1760 to 1844. Since 1849 it has largely increased in the hands of Messrs. Atkin and Sons, who now employ more than forty hands in this one department.

The planing machine has naturally reduced the demand for ordinary planes, since grooving and tongueing, jointing and rebating, can all be performed at one operation on the wood passing through the machine. The moulding machine has also effected a great economy of labour. Two steel cutters of the required moulding are fixed in a block at opposite sides, and the block, being fixed on a shaft or spindle, is made to revolve rapidly, the wood out of which the moulding is to be made being passed under the cutters. A man can produce the moulding by this means as fast as he can walk to pass the wood through the machine.

Machinery has been employed for the manufacture of hand-planes, but with little success. The irregularity in the thickness of the irons requires the exercise of considerable skill in "bedding" them upon the wood, and hand-labour is indispensable to effect this bedding properly. Unless this point is attended to, the tool jumps over the wood it has to plane, and makes it rougher instead of smoother. Since 1825, the woods for planes have been cut by the circular saw, and since 1849 the same tool has been employed in the partial manufacture of planes, squaring up, cross-cutting the ends, and scaeing and tapering the work, thus relieving the workman of the heaviest part of his labour. Women are only employed in wrapping-up, oiling, and other warehouse work.

About 200 hands are employed in this trade in Birmingham, at wages varying from 25*s*. to 50*s*. per week. The social condition is decidedly improved, but the influence of trades' unions appears to have been to some extent injurious.

Fire-Irons.—Fire-irons were originally made by simply heating bars of iron in the forge and hammering them into shape. The process, however, is now performed much more rapidly and accurately by "lapping," *i.e.*, turning a piece of hot iron round the heated rod wherever a swell or knob is required, placing the part thus thickened between two dies of the requisite form on the anvil, and striking the top die with a heavy hammer, thus welding the two pieces of iron together into one of the desired shape. The twisted shanks, now so much in fashion, are formed in the same way, the heated iron being drawn through a pair of dies about three inches long bearing the impression of the required twist. When cold the irons are filed all over, to remove the "scale," this operation being generally performed by boys. They are then case-hardened by exposure to great heat in an iron box filled with charcoal. They are next "bobbed," the "bob" being a wooden wheel covered at the circumference with glue and emery, which forms a substance so hard that the sparks fly as if the iron were ground on solid stone. Every set of irons has to pass over many bobs, shaped to fit the several parts of the outline, the length of plain shank being ground on a wheel not unlike a Somersetshire cheese, while the intricate portions of the pattern require narrow bobs with rounded edges. From the bobs the irons are removed to the "laps," or revolving wheels of white metal composed of tin and zinc, which have to be made of as many shapes as the bobs. When the scratches left by the bobs are all removed the final polish is given by hand, the fire-irons being placed in a lathe and a woman pressing a palm-full of emery against them. Those parts which cannot be polished in the lathe, such as the bows of the tongs, are rubbed by hand. The pans of the shovels are cut out of sheet iron by a heavy press, worked either by a screw or by steam. If the pan is pierced the operation is performed in another press, the little bits cut out being sold to the gun-barrel makers. If required bright, the pans are then ground on a stone and bobbed. They are then hollowed by two blows from another press and are ready to be rivetted on to the shanks.

More fire-irons are sent to Germany than to any other European market. They are light and small. A few of the same character, but better finished, are shipped to France. Besides Birmingham, the manufacture is carried on at Dudley and Wolverhampton, and to a small extent in Sheffield. The number of comparatively large masters in Birmingham is now 12, and of working masters, 35. 260 men, 26 women, and 36 boys are employed. In Dudley, Wolverhampton, and the neighbourhood, there are 17 masters, 170 men, 26 women, and about 30 boys. In 1849, the number of masters in Birmingham was 35, but the small increase in this respect since that time by no means represents the progress of the trade, since in this manufacture, as in many others, large factories with increased capital and improved appliances are gradually supplanting the smaller ones. As any man who can wield a hammer can soon learn the trade, the class of artisans employed in this manufacture is not one remarkable for intelligence and sobriety, but there are many steady men in the trade who can earn full 60*s*. per week.

This is one of the Birmingham trades in which a workman may easily become a master; a loan of £5 being sufficient capital with which to start in business. Several such masters are to be found in shops, once may be stables or washhouses in a back court up an entry. The plant consists of a forge and anvil, a few pair of dies, three or four hammers, a vice and a file, and the casual visitor may stumble over the stock of iron in stooping to enter the door. The pans are bought from a "stamper and piercer," and the work is "bobbed" and "lapped" at "the mill," an institution common in many of the smaller trades of the town—where copper is "spun" into warming pans, spoons are "buffed," snuffers "coloured," &c.—kept by another tradesman who owns or hires steam-power and sublets it for temporary use to those who may require it.

FENDERS, GRATES, AND LIGHT IRON CASTINGS.—The manufacture of cast-iron fenders appears to have been commenced in this town about forty years ago, when they began to supersede the elaborate and costly fender of steel, of rolled brass, or pierced sheet-iron. The first is still sometimes to be seen, its almost unlimited wear justifying the great price that was paid for it. The brass fender is now entirely extinct as an article of regular manufacture, and the pierced-iron very nearly so, there being but two makers of them in Birmingham. These changes have been effected by the gradual cheapening of the manufacture, combined with the increasing appreciation of the suitability of cast-iron for a purpose in which a certain amount of solid stability may be made ornamental at a slight cost.

At first, the fronts of fenders were cut in short lengths, and screwed together; but this plan was soon abandoned, as it was found that the screws often got loose and came out. The manufacturers then adopted the method now generally in use, of casting the fronts in one length, which saves much time in fitting, and makes a far better article. The rapidity with which fenders are now cast, filled with sheet-iron bottom plates, and blacked or bronzed, may be inferred from the fact, that one manufacturer making the cheapest class of work, and employing thirty people altogether, turns out no less than 100 dozen fenders a week. Perhaps a still more surprising statement is that, though he sells some of them at 11*s*. per dozen, his casters earn about £3 a week. This would be impossible if his arrangements were not so made that his men never have to stand still for anything, the materials required being always ready to their hands. Though so many of these cheap fenders are made, it is a satisfactory sign that there has lately been an increasing demand for the better class of work. Beyond Great Britain the chief markets for fenders are the British Colonies. A few are also sent to the free cities of Germany. Scarcely any go to France; partly because few are used there, and partly also on account of the difficulty of getting articles so large and yet so fragile to their destination, through various changes in transit, without breakage. Were it not for this risk we should be able to compete successfully with the French makers.

The stove grate trade was a very small branch of manufacture in Birmingham till within the last few years, but in that time it has made considerable advance. We are indebted to the tyranny of the Trades' Unions of Sheffield for the removal thence to Birmingham of a manufacturer who is making a reputation for our town in this branch of trade. Before 1855 he had works in Sheffield, where there is a union among the "casters," and another among the "grinders." The latter were especially stringent in their regulations. If, as sometimes happened, the master had so many orders on his books that he was actually obliged to refuse more, he could not take on another lad without consulting the men, who reported his wish to the committee of the union. This august body sent deputies to make enquiries whether in the plentitude of their grace they might vouchsafe to grant the humble petition of the employer. If the report were favourable he was permitted to take the desired youth into his service on condition that the lad was a son or near relation of some member of the union. Sometimes, however, the refusal of more orders by the master, from inability to execute them, was the inevitable consequence. Moreover, if it was found by the union that a man was working so steadily as to gain the highest possible wages, and thereby let the master see what very large sums could be earned if men lost none of their time, a deputation waited upon the man and carried him off to the nearest public house, where they kept him drinking for two or three days. It is not, then to be wondered at that a master should try to escape from the reach of influences so detrimental to his trade. The gentleman in question removed to Birmingham, and some of his steadfast men came with him, glad to be themselves out of the tyranny of the union. Other Sheffield manufacturers have followed his example. Some have gone to Rotheram, and one to Derby; and a once flourishing trade has been to this extent expelled from Sheffield by the folly of the men. Here, the materials used cost the same; good sand for ordinary castings can be obtained from the neighbourhood; and the fine loam sand of Mansfield, used for the best castings, is no dearer in Birmingham than Sheffield. Scotch iron is the same price in both places, and the Staffordshire iron is as good as the Yorkshire for best work. Owing to there being no union in Birmingham, the difference in wages makes a reduction in the cost of the finished article of about fifteen per cent., one process being actually forty per cent. cheaper than in Sheffield.

The continental countries to which most grates are sent are Spain and the German free cities. The Sultan of Turkey has lately taken a fancy to English grates, and has had some of elaborate and expensive style made in Birmingham; his example has been followed by the Pacha of Egypt. Some stoves are sent to France, but scarcely any to America, and none to Prussia, where the duty of 25 per cent. is prohibitive. The Palace at Brussels has been fitted up with grates large enough for an ample supply of the peat that warms the royal household of Belgium.

The approximate number of people employed in the fender and grate trade in Birmingham is 500, of whom about 50 are women, and 150 boys.

Amongst the miscellaneous articles made by the manufacturers in this trade are cast-iron hat and umbrella stands, door porters and knockers, garden seats and tables. One manufacturer has for some time past been making an almost incredible number of stands for patent sewing machines, the machines themselves being made in Canada; but as iron casting is so much cheaper here than there, the machines destined for the English trade are sent over and fitted on to their stands or tables here, thereby effecting a considerable saving of expense in freight.

Umbrella and Parasol Manufacture.—Dryden, Gay, and Swift all mention the umbrella as an article of convenient luxury employed by the ladies of their day; but Jonas Hanway, the "friend of chimney-sweeps and sworn foe to tea," some years later, was the first Englishman who dared the ridicule of the public and defended his wig by adopting its use. Even a century ago it was a novelty unheard-of in most parts of the country, and in Glasgow was unknown till 1782. It was not till quite the close of the last century that umbrellas became common, and a strong prejudice against their use by the male sex has been perpetuated almost down to our own day.

The greater part of umbrella and parasol "furniture," both for the home and foreign trade, has long been manufactured in Birmingham, a small proportion being made in London. The manufacture is also carried on to some extent in France, Germany, and America. The "furniture" includes the runner, cap, ferrule, wheel or top-notch, stretchers, ribs, top and ball-tops, collars, swages, and bag-slide or cover.

The first umbrellas were covered with oiled silk or cloth, which gradually gave way to Scotch and Manchester ginghams, generally of green with striped borders of red, &c., these in turn giving way to brown ginghams. Lustring and twilled silk were also employed, but their expense prevented their being generally adopted. Alpaca, a cloth made from the wool of the Peruvian and Chili sheep, was introduced by Messrs. Sangster, of London, in 1851, and has since gained wide acceptance. Fox's "paragon" frame, in which the steel ribs have a section of three sides of a square, had been introduced the year before. The idea was suggested by the construction of the Menai tubular bridge, and the strength, combined with lightness obtained, has rendered the patent justly popular. Before this time round steel wires had been used for ribs, and are still in general use, having to a great extent superseded the whalebone and rattan-cane formerly used. The first sticks used were those with straight swelled beaded handles. These were followed in succession by yellow wood handles ribbed and dotted, horn hooks, moulded horn handles with heads of horse or dog, fist-and-ball, in black or red; then by bamboo-canes with ivory heads; then by an innumerable variety of patterns, in all kinds of material, horn, bone, ivory, agate, &c., &c., which have lately given way to the root-ended sticks now almost universally used. Brass tubes were used for sticks many years ago. These were superseded by japanned iron tubes, still largely in use, particularly in the export trade. The old square copper-wire stretchers have long been obsolete, as have the tinned iron, lacquered and white, except in a small department of the export trade. Brass bell caps and rings, also, are now almost exclusively confined to gig-umbrellas. The brass top-tips cast and drilled, brass ball tips in which the balls were cast and the tube part soldered on, as well as those afterwards made in ivory, bone, ebony, and black japanned iron, have all disappeared, the tip now forming part of the rib. The long six-inch runners have universally given way to the short two-inch ones with hand-spring slot, as have the long three-inch ferrules to black japanned or bronzed. The ring with which the old-fashioned umbrella was kept closed when not in use, first made of brass, and later of ivory, yielded to the tape and button, and this again to the elastic with ring and button now in use. The elastic steel ribs are made of wire procured from Sheffield, where a considerable number of ribs are also manufactured. The London and Manchester wholesale makers are by far the largest buyers of umbrella furniture. Some is sold in Glasgow, Bristol, &c., besides that supplied for export. Many of those in various parts of the country who formerly purchased furniture, silk, gingham, sticks, &c., and made up the frames and covered them, now purchase umbrellas, ready-made from London, Manchester, &c. Almost every manufacturer of furniture has now a resident London agent, and a full assorted stock of goods in town. Owing to the nature of the demand, and the condition of the trade, manufacturers are obliged to make their goods from one to two years in advance of the actual prevailing fashions. Steam is applied to the production of various parts of umbrella-furniture, but they continue also to be made by hand with lathes, and hand-work presses. The number of persons employed in Birmingham in the manufacture of furniture, steel-ribs, &c., is about 120 men, 214 women, 154 boys, and 258 girls. The facilities afforded for the importation of silks by the French Treaty, and the advanced price of cotton, have greatly lessened the number of cotton umbrellas manufactured.

PARKESINE, so called from its inventor, Mr. Alexander Parkes, of Birmingham, is a material made from pyroxyline and oil, partaking in a large degree of the properties of ivory, tortoise-shell, horn, hard wood, india-rubber, gutta-percha, &c., &c. It can be made transparent or in any colour; can be moulded or pressed, turned, carved, and rolled into sheets, and is unaffected by the atmosphere or by water. It is available for spinners pressing or embossing rolls, knife-handles, combs, brush-backs, shoe-soles, floor-cloth, whips, walking-sticks, buttons, brooches, bookbinding, waterproof sheets, coating for telegraph wires, &c., &c. The pyroxyline can be made from any vegetable fibre, but cotton and flax waste, rags, paper-makers' "half-stuff," are principally employed, the solvent used being naphtha, vegetable or mineral, solidified with chloride of sulphur. Other materials and solvents can also be used, and for large and cheap applications sixty per cent. of pigments, saw-dust, or cork-dust may be introduced. Some specimens were made of this material as early as 1856, but it was not till the Exhibition of 1862 called attention to it that the invention produced any practical results on a large scale.

SURGICAL INSTRUMENTS are made chiefly in London, Sheffield, and Edinburgh, but Birmingham has for many years produced considerable quantities, and during the last ten years the demand has greatly increased. The army and navy contracts are supplied by London houses, and even during the Crimean war the provincial productions were ignored, although equally good in quality and much lower in price. The Jurors of 1851 reported that the provincial makers were closely following their London rivals, and since that period the quality and quantity have both improved, as it is stated that twelve and a half per cent., or one in eight require some form of truss, it is not surprising that the trade is very large. It is chiefly carried on in the provinces—large quantities being made in Birmingham. Mr. T. P. Salt was one of the first to improve the manufacture by the use of machinery, and he has invented many forms of surgical apparatus adapted to the various deformities of the human frame.

RAILWAY ROLLING STOCK.—The rapid growth of the railway system, both in this country and abroad, has caused an immense demand, for many years past, for rolling stock of every description, to accommodate the traffic which, in its enormous development, has exceeded the most sanguine expectations of the promoters of the various railways, and has caused the establishment of numerous manufactories to meet the demand.

Formerly, this trade was entirely in the hands of a few private firms, who were soon quite unequal to procure the large amount of capital required to meet the pressing demands of the railway companies who, year after year, were constantly finding themselves short of stock to work their rapidly-increasing traffic. This led to the establishment of works by the railway companies themselves, with the view of meeting the difficulty by becoming their own manufacturers, and, for a time, the plan succeeded; but, as the mileage increased, and, consequently, also the stock required to work it, they found that the principal part of their business would consist in keeping their existing stock in repair, and that they had but little time for building new vehicles. The old system of employing contractors was again resorted to, and has been adopted ever since. The magnitude of this trade attracted the attention of capitalists, and in due course led to the formation of numerous joint-stock companies, all of whom are doing a fair business; and these, coupled with a new system which has sprung up of late years, by which rolling stock is supplied to railway companies and other parties, either for cash or deferred payments, extending over a series of years, form a sound and legitimate employment for the capital raised, and in most cases the dividends of the various companies are very satisfactory.

Birmingham, so far back as the year 1838, commenced the building of railway carriages and wagons, though only on a small scale, but from its central position it early attracted attention as a locality admirably adapted for the purposes of the manufacture, situated as it is in close proximity to the iron and coal districts, and about equally distant from the ports of London, Liverpool, and Bristol, for the timber required. The trade has been constantly growing in this neighbourhood till it has assumed most important proportions, and finding employment for the following companies, viz.:—Midland Wagon Co., Metropolitan Carriage and Wagon Co., Brown, Marshall, and Co., Oldbury Carriage and Wagon Co., and the Birmingham Wagon Co.

These five companies employ in the aggregate not less than 3,000 persons, and use the most extensive and costly plants of machinery daily in building carriages and wagons of every conceivable variety of form, design, and material, to suit the varied requirements of the home and foreign trade.

At the present time there are 12,000 miles of railway in work in the United Kingdom, and the number of passenger carriages with which they are worked is about 15,000, and of wagon stock upwards of 200,000. The value of the entire rolling stock of carriages and wagons in this country may be taken at about £17,000,000, and upon this amount the annual depreciations amount to at least £1,250,000.

The system of private owners' wagons running on the various railways has developed a very large and complicated business for maintenance, and which is principally done by contract by the different rolling stock companies at a fixed price per waggon per annum, involving the necessity of their having repairing stations in many different parts of the country to carry on the necessary repairs without incurring the expense of having the wagons returned to the principal works. The amount of detail and care required in the successful management of this portion of the business is very great, and necessitates the most constant attention to prevent unnecessary detention of the wagons. Some idea may be formed of the foreign and colonial requirements for carriages and wagons from the official returns of the exports in 1864, which amounted to no less a sum than £328,420. This demand still continues, and the present year will no doubt prove equally satisfactory.

THE CHEMICAL TRADES.

[For the following reports the Editor is indebted to Mr. A. W. Wills, the Secretary of the Sub-Committee appointed to report on the Chemical Trades.]

NICKEL GERMAN SILVER MANUFACTURE, BY STEPHEN BARKER.—There are few metals whose history is more instructive than nickel; originally to the miners a source of trouble and annoyance, it has, by a happy combination of scientific observation and manufacturing enterprise in our countrymen, one may, indeed, say our fellow-townsmen, become developed into an important branch of manufacturing industry; and is, under its various forms, not only an article of luxury, but one of daily use and necessity to thousands.

Although the Chinese appear to have been acquainted with some alloys of nickel, one under the name of "packfong," or "white copper," having been imported in small quantities, it was quite unknown in Europe until about the middle of the last century. About this period, the miners in the silver and copper mines of Sweden and Germany came upon certain ores of a different character from any they had hitherto observed, they had something of the brilliancy of silver, with the reddish tinge of copper, or rather of bismuth. At Schneeberg, in Saxony, where from time immemorial such silver mines had existed, fresh lodes of ore were laid open, so glittering and so full of promise as to cause the greatest excitement; and great was the wrath, and bitter the disappointment of the honest German miner when after endless labour and innumerable trials, instead of the virgin white precious metal, ductile, malleable, and indestructible by fire, all that he could get from the ore was a dirty whitish metal, brittle and friable even to dust under the hammer, and converted by fire into a greyish ash.

Wherever the reddish white ore turned up the miner knew that his labour was in vain, until at length in sheer vexation, he nicknamed the new villanous ore "nickel," and another and similar ore generally associated with it, "cobalt;" both these names being at that time applied by the superstitious German miners to certain gnomes or evil spirits of the mountain or the mine, closely allied to our own "Old Nick," and "goblin," who were supposed to have bewitched the ores, the mountain, and the mine. On account of the colour of the ore, it was sometimes called *kupfer* nickel (nickel copper). Indeed, as early as 1694 (?) we find mention in Hume's works of "kupfer trügling," "copper cheat." Kronstadt, the great Swedish chemist and mineralogist, appears to have first examined the nature of the new metal in 1751, from specimens obtained by him in the mines of Helsingland. After five years of labour he pronounced it a new element, and classed it among the semi-metals discovered by him. He appears to have been the first chemist who obtained it as a regulus, and he called it kupfer nickel könig (King Nickel Copper). Kronstadt's nickel was very impure. Bergman spent much labour in trying to purify it and in studying its properties; he found that it had many in common with iron, so that he conjectured it might be only iron in a peculiar state; but he announced his hypothesis with due reserve and caution until nickel should be produced from iron.

Kronstadt and Bergman's researches directed the attention of chemists generally to the new metal, and Thinard, Lampadius and Berzelius contributed to its history. Richter, of Baden, first produced it in a state of chemical purity, in the year 1804, but only in very small quantities. The method he adopted was by heating the oxide of the metal (probably with the *accidental access* of carbonic oxide) in porcelain retorts, and from its supposed reduction "*per se*" it was at first classed among the precious metals. Its great resistance to fusion for a long time formed an insuperable bar to its use in the arts, until a method of alloying it with zinc was discovered, it then became easy to alloy it with other metals, and finally the alloy of the three metals, copper, zinc, and nickel, was known in commerce under the names of new silver, nickel silver, German silver. In the year 1827, a paper, by Dr. Otto S. Erdman, Leipsig, "Ueber das Nickel, seine Gewinnung, ("On Nickel, its Method of Extraction from the Ore,") attracted much attention, and soon afterwards Dr. E. A. Geitner, a chemical manufacturer, at Schneeberg, succeeding in producing an alloy of copper, zinc, and nickel, of excellent colour and quality, to which he gave the name of argentan.

It is a well-known fact that mankind was, at a very early period, acquainted with some alloy of a silver-like appearance and character. The Chinese metal "packfong" has been before alluded to; it was used in the manufacture of musical instruments peculiar to the Chinese, such as *gongs*, &c., and was supposed to have specially excellent sonorous properties; its exportation was strictly forbidden, nevertheless small quantities occasionally found their way into Europe, and were used for mountings and various fancy articles. Its price was about 12*s.* a pound.

Up to the year 1820, the composition of this "packfong" was unknown, when Dr. Fyfe, of Edinburgh, made an analysis, and found its composition

25·4	Zinc
40·4	Copper
31·9	Nickel

But according to another authority, Engeström in 1776, had already analysed a specimen, and found it composed of

40·625	Zinc
43·750	Copper
15·625	Nickel

A similar alloy was produced more than a century ago at a famous manufactory in Luhl, but the method was kept a profound secret, all that was known being that the materials were obtained from some old abandoned mines at Luhl, and consisted of slag left by smelting copper ore, and most likely containing nickel.

This slag, according to Brandes (Schweiz: Ann: 39. 1. 7.), was composed of

8·75	Nickel
88·00	Copper
0·75	Sulphur and Antimony
1·75	Iron and earthy matter

By smelting this with large quantities of zinc the Luhler white copper was produced. It was, however, yellower, and not so malleable as "packfong" metal. (Ann. de Mines, 1825.)

Although, after Kronstadt's discovery, attention was generally directed to utilise the new metal and various alloys, introduced under the names of white copper, semi-argent, new silver, &c., the extent of manufacture was quite insignificant previous to about the year 1830. About that time, the refining of nickel was first introduced into England by Mr. P. N. Johnson, of Hatton Garden; and soon afterwards, Mr. Hallett, of Broadwall, London, commenced the refining of nickel. At this time, the price of nickel was 4*s.* 6*d.* per pound. The nickel of commerce was, up to this date, very intractable for all the purposes of manufacture, except for casting. Spoons, forks, &c., were, until this date, mostly cast in sand. About the year 1832, a great improvement took place in the refining of nickel. Mr. Askin, at that time following or studying the profession of a veterinary surgeon in Birmingham, had occasion to visit several parts of Germany on business, and having a good knowlege of chemistry for that period, he there became acquainted with certain facts relative to the refining of nickel, which led him to devote special attention to the subject; and on returning to Birmingham he succeeded in refining nickel by a purely chemical process. Up to this period it had been refined by the igneous process alone. Mr. Askin succeeded in doing so by the wet process, *i.e.*, he dissolved the crude metal in acids, and precipitated the baser metals, so as to leave the nickel in solution, which was then precipitated in the state of oxide. Mr. Askin entered into partnership with the Messrs. H. and T. Merry for the purpose of carrying out his discovery and manufacturing German silver; but the firm did not long subsist, nor did the manufacture make much progress. After the dissolution of this partnership, Mr. Askin entered into partnership with Mr. Brooke Evans, and under the firm of Evans and Askin, the German silver trade rapidly extended.

In the year 1840, or thereabouts, the process of electroplating and gilding first began to develop as a successful manufacture, chiefly under the auspices of the Messrs. Elkington. This gave a powerful impulse to the German silver manufacture, which, from its greater beauty and durability, soon superseded the old-plated copper; and it had the great advantage, that whereas copper must always be stamped, or spun at a lathe, German silver can be either cast or wrought into a finished design of any article before plating. In or near the year 1841, Messrs. Webb and Barker commenced the trade of nickel and cobalt refining.

Nickel and cobalt, found originally at only a few mines in Sweden, Norway, and Germany, are now found in almost all parts (*i.e.*, where the mining formations exist), both of the old and the new world. It may be observed that, although the ores of Norway and Sweden are not very rich, they, by their abundant supply, contribute very largely to our nickel manufactures. One of the most prosperous nickel mines is at Canton Valais, in Switzerland, but it is now nearly closed. As a rule, the mines are not worked for nickel alone, but as an adjunct in mining for other minerals.

The price of the metal has varied considerably. In 1840, it was 4*s*. the lb., in 1849, it had risen to 13*s*., but it has since gradually come down until its present price is again 4*s*. 6*d*. per lb. It is used (as German silver) in the manufacture of a vast number of articles, such as table plate of all kinds, harness and saddlery furniture, spurs, stirrups, lamps, gun furniture, &c.

Commercial nickel, although sold in ingots like the malleable metals, will not roll; this difficulty of obtaining it quite malleable, which it is when *chemically* pure, has perhaps been a cause of its being only hitherto employed as an alloy, (German silver,) which is composed according to the requirements of the manufacturer of various proportions of nickel, copper, and zinc. The chief makers are Messrs. Evans and Askin, Mr. Stephen Barker, Mr. William Webb, of Birmingham; and Messrs. Vivian, of Swansea. Intimately associated with the refining of nickel is that of cobalt, as they are very generally found together in their ores. Cobalt has been used in the impure state as "*zaffre*" for imparting the intense blue of porcelain and the better kinds of pottery, from time immemorial, but about the year 1840 Mr. Benson, of this town, succeeded in refining cobalt by a purely chemical process, however, he had scarcely brought his discovery to perfection at the time of his decease.

It was afterwards completed and carried out by Mr. Askin; and Messrs. Evans and Askin continue up to the present time the chief makers of the oxide, that being the state in which it is now used. In 1844 the price was 40*s*. per lb., but it has been gradually reduced until now it is only about 12*s*. per lb.

The number of persons employed in the nickel and the German silver manufacture is in Birmingham 7,000; Sheffield 5,000. This includes, of course, the manufacture of the various articles for which German silver is used.

The production of refined nickel at this time is about 200 tons per annum, equal to about 1,200 tons of German silver.

WAX VESTA MATCHES, BY GEORGE DOWLER.—This manufacture is extensively carried on by Mr. G. Dowler, at the Plume Works, Aston, the principal demand being for the supply of foreign markets. The general character and appearance of the now well-known Vesta Matches needs no description, but it may be stated that the substance which is employed in their manufacture, and whence they derive their name, consists of a mixture of white wax and stearine, the preparation of which latter is highly interesting. The raw material consists of impure and high-coloured grease, derived from various sources, including a large quantity obtained as a waste product in the wool trade. This is distilled, in charges of five tons at a time, at a temperature gradually rising to 600° F., assisted by a copious injection of high-pressure steam. The first and last portions of the distillate are rejected, and added to subsequent charges; the intermediate product, though of a much lighter colour than the original material, is still in an impure condition, requiring further treatment. It is now submitted in the cold to a hydraulic pressure of 400 tons, whereby a considerable quantity of oil is driven out, and thence transferred to similar presses, surrounded by jackets into which are introduced jets of steam. A further quantity of oil is extracted by this process, and the two portions are then mixed and subjected to the ordinary processes of refining, whereby the oil is again rendered saleable to the wool manufacturer, from whom it returns charged with fatty matter again to undergo the above processes. The white cake which remains between the plates of the hydraulic press is stearine in a state fit for use in the manufacture of matches. These are produced in vast lengths, amounting to from 55 to 60 miles per diem, which are then cut up into the requisite sizes by ingenious machinery, tipped with the inflammable composition, and packed in paper or tin boxes (the bottom of which contains the usual rough surface for lighting), and holding from 50 to 1000 matches each. That branch of Mr. Dowler's works which is devoted to this trade (and which forms but a small portion of his large establishment), and to the stamping, pressing, and finishing of the boxes, affords employment to about 300 women and children. It only remains to be stated that every precaution has been adopted for the safety and health of the persons employed in this curious and interesting manufacture.

Metal Refining.—This trade consists of two branches: First, the recovery of the precious metals, gold and silver, from the scraps, dross, filings, sweepings, and other refuse of the shops of the jewellers and various workers in these substances, and from the sediment of the "pickling liquid" used by the brassfounders, by means of washing and other suitable mechanical operations and subsequent chemical processes;

second, of a similar treatment of "brassfounders' ashes." This latter consists of the scraps, ashes, or dross, broken crucibles, and other refuse from the manifold trades in which brass is so extensively used in this town, and is produced probably to the amount of 3,000 or 4,000 tons per annum, varying largely in respect of the percentage of metal which it contains according to the particular source whence it is derived. The "ash" is washed in order to separate the lighter and less valuable portions, ground, calcined on the hearth of a reverberatory furnace, and finally smelted in crucibles or "pots" with suitable fluxes, in order to recover the metal. This trade, although not employing throughout Birmingham more than 150 hands, is of considerable interest as subsidiary to the brassfoundry, which constitutes so important an item among the staple manufactures of this district.

PHOTOGRAPHIC AND OTHER CHEMICALS AND PHARMACEUTICAL PREPARATIONS.—We are indebted to Messrs. Bailey and Son, of Wolverhampton, for the following list of the principal substances manufactured in their establishment:—

Glacial Acetic Acid, made from pure Anhydrous Acetate of Soda, rectified with Binoxide of Maganese. Acetate of Soda and Bichromate of Potash, used for dissolving essential oils in photography, and for various other purposes. Two qualities are manufactured, the one monohydrated, the other containing 95 to 98 per cent. of Monohydrated Acid. Arsenic Acid, anhydrous and in solutions of 60° and 70° Baumé, used chiefly in calico printing, dyeing, and manufacture of aniline red. Benzoic acid Butyric, used principally for preparing artificial essence of pine apple, &c., Formic, dilute by Berthelot's new process from Oxalic Acid and Glycerine, monohydrated, from anhydrous formate of soda. Hydrocyanic, Hydrofluoric, Hydrofluosilicic, for preparation of Chloric Acid in the manufacture of Chlorate of Baryta; Hydrochloric, free from Arsenic; Nitric, pure; Phosphoric, glacial; Sulphuric, pure, re-distilled and free from Arsenic. Valerianic, free from fasel oil; used for medicinal preparations, as valerianates of zinc, iron, quinine, &c. Chrome alum is obtained as a bye-product in considerable quantities, but has not yet been turned to any practical use. Ammonia, caustic pure, sp. gr. ·880, ·890, and ·940. Ether, pure, sp. gr. ·720, for photographic and medicinal use. Antimony-sulphide, for medicinal use by decomposing solution of "Schlippe's Salt," or Sulphantimoniate of Soda, previously re-crystallised, by sulphuric acid; for industrial purposes, by decomposing the impure solution of Sulphantimoniate of Soda or Lime. Barium-Chloride; Baryta, Nitrate, and Chlorate, for pyrotechnic use, giving the finest green colour yet known for this purpose. Carbon Bisulphide, crude and rectified. Chloroform. Chrome, green oxide of, or chrome green. Collodion, for photographic purposes, both from pure and methylated alcohol, and ether, sp. gr. ·720. Essences: fruit essences, both from the natural fruit, and artificially from organic ethers, for confectionery, for flavouring liquors, &c. Gold Chloride, containing 50 per cent. metallic gold, for photography. Iodine, resublimed. Iodide Potassium, Ammonium, Cadmium. Iron, pure protosulphate; Saccharo-sulphate; Ammonio-sulphate, Citrates and Tartrates, and those of Iron with Ammonia, Potash, and Quinine in scales. Lime, Bisulphite; lately recommended by Dr. Medlock as a means of preventing fermentation of ale, porter, &c., in the casks. It is manufactured of sp. gr. 1·070, and when used a few ounces are mixed with the ale or other liquor; no effect is produced upon its taste, smell or wholesomeness. This substance is now largely used by the principal brewers in this country, and is also specially adapted for hot climates. Mercurial preparations; Calomel, Corrosive Sublimate, Ammonio-Chloride and Red Oxide (Red Precipitate). Potash, Acetate; extensively used for medicinal and other purposes, and produced in the form of large masses of a beautiful snow-white crystalline structure, by allowing the fused Acetate to cool in iron cylinders, closed by lids which are gradually screwed down as their contents cool. Potassium, Cyanide by Liebig's process, largely employed in electro-plating, &c. Potash Caustic, in solution, cakes and sticks. Pyroxyline, both from cotton wool and paper, for manufacture of Collodion. Silver Nitrate, fused and recrystallised for photography. This is manufactured from commercial samples of silver, and the gold which they contain, often in considerable quantity, recovered in the process. Soda, Hyposulphite, recrystallised for photographic use. Soda Potash, Silicates of, in a white porous condition and not manufactured in the reverberatory furnace. Strontia, Nitrate, in large white crystals, for pyrotechnic use. Zinc; Acetate, Chloride, Sulphate, Valerianate, for medicinal use.

CITRIC ACID.—The works of Messrs. J. and E. Sturge, Wheeley's-lane, Birmingham, are chiefly devoted to the manufacture of Citric Acid, and have been established more than forty years. This article is made from the juice of fruits of the citron tribe, principally from the citrus acidus, (the lime of the tropics,) the citrus limonium, or lemon, and the citrus bergamia, or bergamot lemon, the former containing the most citric acid, and the latter the least. The juice used in the manufacture is imported from Sicily in a highly concentrated state, its market value varying greatly, viz.: from £15 to £30 per pipe. After the rind has been used for the separation of its essential oil, the juice is expressed from the fruit and evaporated to about one-sixth of its original bulk, previous to shipment. In the shipment of lime juice from the West Indies, the concentration is carried still further, the juice of five tons of fruit being reduced to the dimensions of a fifty-gallon cask. The acid is separated from the impurities with which it is associated in the juice, by Scheele's process of combination, with lime and subsequent decomposition by sulphuric acid. The commercial product consists of pure white transparent crystals, very soluble in water, and of an agreeable acid taste, and the amount annually manufactured approaches 300 tons. From the varying yield of the lemon crop of Sicily the price of citric acid is subject to corresponding fluctuations, and has ranged during the last seven years from £150 to £300 per ton. The chief commercial uses of this substance are in the manufacture of cooling drinks, in dyeing, and calico printing.

PHOSPHORUS-CHLORATE OF POTASH.—The principal manufacturers of these substances having declined to furnish reports upon this subject, it remains only to state that the most complete and reliable account of the production of phosphorus extant will be found at p. 93 of Dr. Hofmann's report of Class II., sec. A, in the Exhibition of 1862, while a full outline of the manufacture of chlorate of potash appears at p. 38 of the same report.

ARTIFICIAL MANURES AND SUPERPHOSPHATE OF LIME.—The use of guano in England dates from so recent a period as about a quarter of a century ago, since which time its importation has rapidly increased, with a correspondent advance in price, and a simultaneous introduction of various kinds of guano of less value than that originally brought from the Chincha Islands of Peru. From that date the manufacture of artificial manures, having as their basis superphosphate of lime (derived either from bones, coprolites, or other natural phosphates), and more or less adapted to the growth of particular crops, has gradually extended into a vast and important branch of commerce, involving an enormous development of the import trade in bones and other phosphates, and of the production of sulphuric acid used for their decomposition, and affording likewise the means of utilising the refuse products of our northern woollen factories, and of various other manufactures. The manufacture of artificial manures is now extensively carried on in Birmingham, Wolverhampton, and the district. It is difficult to arrive at an accurate estimate of the total annual produce, but the most competent judges estimate it at from 18,000 to 20,000 tons.

COLOURS, VARNISHES, AND LACQUERS.—Colours and varnishes are extensively produced in Birmingham and the district; and owing to the large consumption of these articles, in the manufacture of Japan wares, iron bedsteads, brassfoundry, bird cages, and general wire work, &c., the trade has assumed a somewhat special character.

VARNISHES.—The chief manufacturer's varnishes are copal or polishing, mixing, japanner's (clock) dial, blue, for edge tool makers, and turpentine varnish (used by Venetian blind makers, mixed with mineral greens).

Mixing varnishes are so called from their being always used, "mixed" with colours, as distinguished from those which are applied upon dull colours or paints; an immense quantity of these is consumed in the manufacture of common bedsteads. The chief black varnishes, which are usually stored, are "black tar varnish," used by hollowware makers, japanners, umbrella makers, button and hair-pin manufacturers; "brown tar varnish," used by match and percussion cap box makers, tinmen, and others; black and brown "Pontypool," or black japan (used for superior work, including its application to coach bodies, upon which it is well rubbed down, receiving, when dry, a coat of "best body varnish," which renews the polish of the japan, and shows a depth of black, only attainable by this method); Brunswick black, used for stove-grates, ranges, and engineers' work, where a good bright, quick-drying varnish is required; "quick iron black," a commoner variety of the above, used largely for blacking iron bedstead laths, iron paint kegs, hinges, and an infinity of other articles; common iron black (a mixture of gas-tar and mineral naphtha), used for common work, where the smell is of no consequence; Berlin black, an expensive black, drying "dead" without heat, and used by makers of superior stoves, ranges, and fenders, also by edge tool makers and others; "Willenhall lock varnish," used by lock-makers, furnishing ironmongery makers, &c. The above are the varnishes special to the district. The following are in ordinary use throughout the country, viz. :—Body varnish, and carriage varnish; principally used by coach-makers; furniture and oak varnish, the use of which is indicated by their names; paper varnish, used by paper hangers; spirit varnish, used by paper-box makers and brassfounders. Closely allied to the above are lacquers, of which there is an immense consumption in this district.

The following are the chief raw materials employed in the manufacture of the various sorts of varnish :—

GUMS.—Gum Animi, a hard gum used in all first-class varnishes. Gum Copal, used in copal, polishing, and oak varnishes, &c. Gum Kowrie, a useful and cheap gum used for making the general class of ordinary varnishes, but of every variable quality. Gum Mastic, used for mastic varnish, principally employed by picture and map mounters, artists, &c. Gum Damar, a soft white gum, mostly used for paper varnish. Gum Amber, or Amber Chippings, the use of which is almost entirely local. Resin, Asphaltum (English and foreign). Seedlac, Shellac, Sticklac, Gum Dragon, Benzoin, Sandrac, Thus, all used in spirit varnishes and in lacquers; of these latter, it may be stated that there are two principal varieties, one made with rectified spirit of wine, which quality sells at about 24*s*. to 26*s*. per gallon, and the other with methylated spirit, and selling at 7*s*. or 8*s*. per gallon.

SOLVENTS AND DILUENTS.—These are: Spirits of Turpentine. Petroleum Spirit, used for cheaper varnishes, where smell is not an object. Since the commencement of the American war an immense quantity of European spirits of turpentine has come into the market, known as French, Polish, Spanish, German, Russian, &c. American refined Petroleum Spirit has also assumed many names, as Rock Spirit, Petrolene, Photogen Spirit, Cazeline, &c. Wood Tar Spirit; Mineral or Coal Tar Spirit; Resin Spirit, the product of distillation of resin; Wood Naphtha; Spirit of Wine, and Methylated Spirit.

"RESISTANTS."—These are generally composed of linseed oil, boiled with certain drying materials, as sugar of lead, red lead, "white copperas" or sulphate of zinc, &c. It is these which, being added to the melted gum in making "clear" or "oil" varnishes, impart to them their elasticity and durability. The linseed oil ought invariably to be subjected to a greater heat in manufacture than the consumer will apply to it in its use. The brown varnishes are made by leaving the oil uncoloured, and the black by an addition to the oil of asphalt or "Liverpool black," a product made from distillation of wood.

Colours, Paints, and Driers.—Of these, the following are manufactured largely in Birmingham, for use in the special trades of the district:—Emerald green, employed extensively for painting iron bedsteads, and for paper staining, &c., &c. Chrome greens, of which there are a great variety of shades and qualities, known in the trade as Brúnswick green, Quaker's green, mock emerald, &c., &c. Prussian blue and Chinese blue, a fine bright modification of the former. Chrome yellow, of many shades, from pale yellow to deep orange. Persian red, and Derby red, the base of which is chromate of lead. Rose pink, made from dye woods. Lakes, crimson and scarlet, made principally from precipitated alumina and cochineal; but of which the finest qualities are supplied by London houses.

Patent Driers.—A preparation made from sugar of lead, white copperas, linseed oil, and baryta, in proportions well-known in the trade, and added in varying quantities to paints to increase the rapidity of drying. An inferior quality is made, containing lime in place of sugar of lead or white copperas.

Paints.—Of these several varieties are produced for use in the trades in the district, but by far the most important is the excellent chocolate, red oxide of iron or Torbay paint, largely manufactured by Mr. William Hall, of Ashted Works, in this town, and principally employed amongst boiler, girder, gasometer, tank, and turntable makers, railway wagon builders, engineers, &c. The theory of its action, as an effectual protection to all ironwork, is self-evident, and the best guarantee for its purity consists in the fact that Mr. Hall has adopted as the raw material a substance charged with a very high percentage of oxide of iron, which he takes by itself, cleans by careful levigation alone, and then grinds finely in oil, thus avoiding the employment of acid solvents and the subsequent precipitation of the oxide, whereby impurities destructive of its special value are frequently introduced into so-called "iron paints." Mr. Hall's production of this article alone amounts to nearly 200 tons per annum. Finally, it may be stated in general terms that the manufacture of Varnish in Birmingham and district exceeds in extent that of any other town, London only excepted; but that, owing to their facilities for shipping, Hull, Liverpool, and Glasgow produce a larger quantity of Paints and Colours.

THE SOCIAL AND ECONOMICAL ASPECTS OF BIRMINGHAM.

BY J. T. BUNCE, F.S.L.

It is thought desirable that this volume should include some notes on the moral and social condition of Birmingham. Space, however, requires that the subjects treated of should be few, and the treatment brief. Assigning the first place to the crime of the town, I proceed at once to show the number and character of the offences committed. Those who desire fuller information may consult the official returns, published annually by the Home Office, under the title of "Judicial Statistics." For the year ending September, 1865 (the latest date to which the returns are made up), the number of the criminal class is estimated by the police at a total of 3,068—rather less than in the previous year. The total is divided as follows:—*Males* under 16 years of age, 291; above 16 years, 1,573. *Females* under 16 years, 164; above 16 years, 1,040. The division into classes is as follows:—Known thieves, 912; receivers of stolen goods, 129; prostitutes, 376; suspected persons, 591; tramps and vagrants, 1,060.

The number of houses of bad character is returned as 866, of which 174 were licensed public houses, 148 beershops, 115 brothels, and 237 tramps' lodging houses.

The total number of offences committed is stated as 1,258 indictable offences, and 9,188 cases of persons summarily proceeded against. For the indictable offences 805 persons were apprehended, and of these 437 were committed for trial. In the previous year (1863-4) the indictable offences were 752; and the summary prosecutions 8,420. For the former 598 persons were apprehended ; and of these 431 were committed for trial. In both classes of offences there is, therefore, an increase in 1865 over 1864, while as regards indictable offences the number of apprehensions has not increased in proportion ; nor has the number of committals in proportion to apprehensions. This would seem to point to diminished activity on the part of the police.

The crime committed in Birmingham is not often of a very serious character. Burglary and larceny (the former, in most cases, being really little more than larceny at night) constitute the chief items under the head of indictable offences. The number of these offences for the two last years were—1864, burglaries and attempted burglaries, 289 ; larcenies, 224. In 1865, burglaries, 417 ; larcenies, 466. The increase is partly due to a general increase of crime throughout the kingdom ; but this does not wholly account for it, and I am inclined to suspect some exaggeration in the number of cases reported to the police. Of coining and uttering false coin, there were 21 cases in 1864, and 67 in 1865. Cases of forgery, receiving stolen goods, embezzlement, and obtaining money or goods under false pretences are much rarer in Birmingham than in most other large manufacturing or commercial towns ; and crimes of violence against the person are neither frequent nor serious. In 1865, for example, there was only 1 attempt to murder, 7 cases of manslaughter, and 24 of wounding with intent to do bodily harm, and this out of a population of nearly 350,000.

Of the lighter class of offences summarily decided, the principal items are larcenies, assaults, (heard on summons,) drunk and disorderly, and offences against local acts. The following is a comparison of those decided in 1864 and 1865 :—

	1864.	1865.
Assaults	1,918	2,145
Drunken cases	1,373	1,706
Larcenies	1,044	1,052
Offences by publicans	459	479
Offences against Local Acts	1,695	1,514
Offences against Vagrant Acts	706	900

Having shown the crime of Birmingham, in character and extent, it may be desirable to show the position held by Birmingham in comparison with the country generally, and with the large towns. The following table will afford the means of comparison for the year 1865 :—

	Population (1861.)		*Indictable Offences.*		*Summary Offences.*
All England	20,066,224	...	52,250	...	458,914
Birmingham	296,076	...	1,258	...	9,188
Manchester	338,346	...	7,351	...	11,172
Liverpool	443,874	...	4,629	...	34,290*
Leeds	207,000	...	512	...	7,044
Sheffield	185,000	...	426	...	5,422

The following tables show the proportion of offences to population under each of these heads, and under both united for the years 1864 and 1865, the calculation being made, in each instance, on the census of 1861 :—

INDICTABLE OFFENCES REPORTED.

	1863-4. 1 in		1864-5. 1 in
All England	394·96	...	384·0
Birmingham	393·72	...	235·39
Manchester	51·08	...	46·04
Liverpool	102·6	...	95·08
Leeds	432·3	...	404·3
Sheffield	446·86	...	434·27

SUMMARY OFFENCES.—PERSONS PROCEEDED AGAINST.

	1863·4. 1 in		1864-5. 1 in
All England	45·5	...	43.7
Birmingham	35·16	...	32·22
Manchester	29·87	...	30·28
Liverpool	12·17	...	12·94
Leeds	33·38	...	29·38
Sheffield	33·6	...	34·1

INDICTABLE AND SUMMARY OFFENCES TAKEN TOGETHER.

	1863-4. 1 in		1864-5. 1 in
All England	40·8	...	39·0
Birmingham	32·28	...	28·34
Manchester	18·85	...	18·26
Liverpool	10·88	...	11·4
Leeds	30·94	...	26·0
Sheffield	33·6	...	30·0

It will be noticed, not without surprise, that in both years, in regard to indictable offences (the more serious kinds of crime), Leeds and Sheffield were much better than the average of the kingdom; while Manchester and Liverpool were much worse. In 1864 Birmingham was about the average; in 1865 it was decidedly worse. Taking both classes of offences together, the large towns in 1865 stood in the following order of merit:—Sheffield, Birmingham, Leeds, Manchester, and Liverpool.

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* It is only fair to Liverpool to say that more than half this number consisted of drunk and disorderly cases, due to the large number of sailors frequenting the port.

Before quitting the subject of crime, a note may be made in regard to prostitution. The estimated number of prostitutes given in the "judicial statistics" must be taken with some reserve, as it is the estimate of the police, and includes only notorious prostitutes; but assuming it to be correct, Birmingham stands remarkably well. The proportion of prostitutes (known to the police) to population is stated as follows:—all England, 1 in 762; London (15 miles round Charing Cross) 1 in 544; commercial ports, (Liverpool, &c.,) 1 in 193; pleasure towns, (Brighton, &c.,) 1 in 243; agricultural towns (Warwick, Ipswich, &c.,) 1 in 309; small and mixed textile manufacturing towns, (Coventry, Nottingham, Norwich, &c.,) 1 in 478; cotton and linen manufacturing towns, (Manchester, &c.,) 1 in 557; seats of the woollen and worsted manufacture, (Leeds, Huddersfield, &c.,) 1 in 654; seats of the hardware trades, (Birmingham, Sheffield, and Wolverhampton,) 1 in 709. In Birmingham itself the proportion is returned as 1 in 868; or considerably better than the average of the whole kingdom. These figures, however, it must be borne in mind, in all cases, apply only to what may be called professional prostitution; and take no count of the casual, or it may be, habitual prostitutes who are unknown to the police.

Crime and overcrowding always go together, like overcrowding and disease. One cause of the comparative freedom of Birmingham from crime, especially serious crime, is that—for its population—it covers more ground than any town in the kingdom. Families very seldom live together: almost each family has its own house; and in not a few instances the house belongs to the tenant. The calculation is that families average five persons; and as a rough way of putting it this may be safely accepted. The estimated population of the borough of Birmingham, in the middle of 1866, (Registrar-General's Weekly Returns) was about 334,000. The number of houses in the borough at the same period was close upon 60,000,—the Electoral Statistics, published in March, return nearly 58,000 *male* occupiers at £4 and upwards.

It has been remarked that many of the houses are tenanted by their owners. The provident habits of large sections of

Birmingham workmen are very remarkable. They earn good wages, and by moderate thrift can afford to lay something by. That they do so is abundantly proved by the large deposits in the savings bank; by the existence of innumerable sick and benefit clubs, in connection with numerous churches and chapels, with various "Orders," such as Odd Fellows and Foresters, and, unfortunately, in connection with almost every public house. As a rule, the genuine Birmingham artisan hates and dreads the "parish." A less gratifying feature is the increase of loan societies, and the remarkable prevalence of public-house money clubs, ranging from a guinea up to £50. In these clubs, priority of drawing is bought by the highest bidder; extravagant prices are given for this privilege, and thus extortionally high interest is paid by many of the borrowers, to say nothing of the drinking habits fostered by attendance at the public house on club nights. The land and building societies, which are numerous, are mostly free from these objections. Full information in reference to these societies will be found in a valuable paper read to the British Association (Section F) by Mr. G. J. Johnson, and published in the "Journal of the Statistical Society of London" (vol. xxviii., p. 507). The earliest society was founded in 1846. Between that date and 1865, the number of members was 25,058, of whom 11,193 remained. The total amount of subscriptions received was £2,242,968, and £539,732 remained due on mortgage, almost exclusively of house property. These figures speak volumes for the thrift of the artisan class. In reference to this question of the provident habits of the workmen, and also in regard to their social habits, modes of life, wages, and other kindred points, the reader may usefully consult Sargant on "The Economy of the Labouring Class" (London: Simpkin and Marshall), a valuable work, the author of which had peculiar opportunities of acquiring full and exact information.

One or two notes must bring this chapter to an end. Notwithstanding the diversity of trades in Birmingham, and the skill and general intelligence of the workmen, co-operation has made practically no progress here. Many years ago a couple of flour and bread companies (the OLD and NEW UNION MILLS) were set up on the co-operative principle; but the shares are now held only by the middle class. A few retail "stores"—grocery and provisions—have since been established: several have failed, and the rest are in a languishing condition. Co-operation in manufactures has not been attempted, probably because, in most trades, it is easy for the workman to start on his own account as a "little master." The present tendency is, however, towards larger manufactories, and this, in time, will doubtless lead to co-operation.

There are many other points which deserve notice; but only one can be touched upon—that of Strikes. In the Birmingham trades proper these are neither frequent nor disastrous. The gunmakers occasionally suffer, so do the flint-glass makers, and sometimes there are strikes in one or other department of the brass trades. The various branches of the building trade have lately been much disturbed by disputes in regard to both time and wages; and the brick-makers appear to be in a chronic state of disagreement with their masters. None of these partial strikes, however, are of much practical importance; the trade of the town is so greatly divided that strikes affect only a small portion of it. With the exception of the brick-makers—probably the lowest and least instructed class—strikes in Birmingham are never embittered by acts of violence, either against persons or property.

THE MEDICAL ASPECTS OF BIRMINGHAM.

By T. P. HESLOP, M.D.

I PROPOSE to give a brief account of this town, from the point of view of health and mortality. In spite of its irregular construction, smoke-loaded atmosphere, dingy-looking buildings, and dense population, Birmingham has for several years enjoyed the reputation of being one of the healthiest large towns in the kingdom. This is partly founded on fact, as I shall presently show; but there can be no doubt that its nearly complete immunity from Cholera, in its successive epidemics, while neighbouring districts suffered so severely from the disease, has been the main cause of that reputation. Various explanations have been tendered, by more or less competent persons, of this immunity, for which an explanation is the more necessary as the cognate diseases, Diarrhœa, Dysentery, &c., are remarkably prevalent in the Birmingham Registration District. It is remarked by Mr. W. L. Sargant,* "all the deaths from cholera, diarrhœa, and dysentery, taken together, are throughout the country fewer than one-twentieth of all deaths. But in the great towns they are far more; being in Liverpool, Birmingham, and Leeds, from one-eleventh to one-twelfth of all the deaths in those places respectively. They are fewer in London and Wolverhampton, and in Bristol they are as few as in the whole country." During the second cholera epidemic, of 1849—50, while there were but a few scattered cases of genuine cholera, there was a prevalence of choleraic diarrhœa of formidable type, which severely taxed the resources of the hospitals and parochial medical officers. It is hardly necessary to direct attention to the grounds adduced for this comparative protection as regards past cholera epidemics. The smallest consideration amply demonstrates their insufficiency to account for it. It is better to discuss the utility of preventive measures, and sanitary improvement, than to repose in a security which probably another epidemic will for ever dissipate.

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* *Vital Statistics of Birmingham and Seven other Large Towns*, 1866. I am under great obligations to this able and accurate writer for some statements in this paper.

One of Mr. Sargant's tables gives the relative prevalence of these intestinal disorders in so clear a manner that I have appended that part of it showing the *proportion* of deaths from these causes to deaths from all causes (1851—60), in England and Wales and eight large towns.

		Cholera, Diarrhœa, and Dysentery.	
England and Wales	Males	4·8	per cent.
" "	Females	4·7	"
Birmingham (Parish)	Males	8·2	"
" "	Females	8·4	"
Sheffield	Males	7·1	"
"	Females	8·4	"
Wolverhampton	Males	6·3	"
"	Females	6.7	"
Manchester	Males	7·7	"
"	Females	7·4	"
Leeds	Males	8·2	"
"	Females	8·0	"
Liverpool	Males	8·5	"
"	Females	9·0	"
London	Males	6·2	"
"	Females	6·4	"
Bristol	Males	4·7	"
"	Females	5·0	"

Arguing from the prevalence of other epidemic diseases in Birmingham, both in the past and at the present, we should still less anticipate its continued freedom from cholera. On the western side of the town, there is a field still known as the "plague field," because of the number of persons dead of the plague in 1665, who were there buried in an undistinguishable mass. Allusion is made to this fact in the article Birmingham, in the "Encyclopædia Britannica." After making allusion to the defeat of the Birmingham men, when opposing the Cavaliers under Prince Rupert, the writer goes on to say :—"A more serious calamity, however, the plague, desolated the town in 1665, and the inhabitants were compelled to bury their dead in a lonely spot called Ladywood, in the outskirts of the town. No records remain to show the number of victims, the entries of burials in the Parochial Registers not exhibiting any increase over their ordinary numbers." That dreadful scourge which prevailed throughout every part of the kingdom in the earlier years of the reign of George the Third, and which was generally known under the name of "malignant sore throat," was very fatal in this town, and was well described by a physician of rare genius, then practising in Birmingham, Dr. Withering. The same may be said of epidemic influenza, and scarlatina.

During quite recent years, an old pest has put on a fresh virulence, and has attracted anew a portion of that attention, to which it was so well entitled previous to the discovery of vaccination. During the years 1864, 1865, small-pox was so prevalent, and so severe in Birmingham, that great alarm was experienced among the public—the more so, as no efficient means of separating those affected from the general sick population, existed then, or exist now, for the warning was allowed to pass by unheeded.

But by far the most remarkable and formidable, next to cholera, of modern epidemics, that of diphtheria, has displayed itself in full vigour in this town.* The cases reported from Birmingham were among the first which occurred in the kingdom, and up to the present time the malady has not died out, though greatly diminished both in frequency and in fatality. I believe the earliest public notice of this disease was contained in an article in the *Birmingham Journal* in the year 1856, wherein the public were warned of the probable approach of what was then often referred to by the travelling portion of Englishmen as the "Boulogne sore throat."

The small mortality of Birmingham, as compared with certain other large towns, has never attracted more notice than during several weeks of this year. Happily, the publication of weekly abstracts by the Registrar-General enables us now to gain authentic information upon the point. For the last week in June and the two first in July the official documents declare that Birmingham enjoyed the lowest death-rate of the ten towns compared. I give the exact numbers for the past two weeks, to enable the reader to form an estimate for himself concerning a matter of deep interest. 27th week of the year, ending July 7th. Rate of mortality per 1000:—Birmingham, 16·9; Hull, 18·3; Bristol, 21·4; London, 22·0; Newcastle, 22·6; Sheffield, 24·6; Manchester, 28·8; Salford, 30·0; Leeds, 36·4; Liverpool, 37·6.

28th week of the year, ending July 14th:—Birmingham,

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* For full information on this subject, I refer the reader to Dr. Headlam Greenhow's work on Diphtheria.

19·1; Hull, 22·3; Salford, 23·1; Newcastle, 23·9; Sheffield, 25·6; London, 26·2; Bristol, 26·8; Manchester, 31·7; Leeds, 32·9; Liverpool, 41·2.

The more complete the comparison of Birmingham with towns of equal magnitude, London excluded, the more secure seems the ground for congratulation. In his Table T., Mr. Sargant gives the annual death-rate from different causes to 10,000 males and 10,000 females living, from 1851 to 1860, in England and Wales and eight large towns. I subjoin a portion of this table, showing the deaths from *all* causes per 10,000.

England and Wales	**Males**	**230**
„ „	**Females**	**213**
Birmingham (Parish)	**Males**	**280**
„ „	**Females**	**250**
Sheffield	**Males**	**295**
„	**Females**	**274**
Wolverhampton	**Males**	**284**
„	**Females**	**267**
Manchester	**Males**	**336**
„	**Females**	**295**
Leeds	**Males**	**294**
„	**Females**	**261**
Liverpool	**Males**	**352**
„	**Females**	**314**
London	**Males**	**257**
„	**Females**	**218**
Bristol	**Males**	**297**
„	**Females**	**241**

Here, however, must terminate our satisfaction with the Birmingham death-rate, and with that fair image of the fancy, the salubrity of Birmingham. It would be sufficiently wonderful if a town could be, in any intelligible sense, termed healthy, when the density of the population is such that there were, in 1860, 5·01 persons to a house, and 100 persons to 1·25 acres, containing, too, a population which was increasing from 1851-60, at the rate of 22·23 per cent., while the per-centage increase of England and Wales, during the same period, was only 11·93. This is the real explanation of the high death-rate of Birmingham, which can never be abolished by the most careful sanitary arrangements. Great density of population means a high death-rate, and will probably have the same significance to the end of time. The centres of wealth will be ever the centres of disease and death. Doubtless the same causes which increase the mortality of men in London, at the working ages, exist in

Birmingham to a somewhat greater degree. They are specified by Dr. Farr* as follows:—"The drainage of their dwellings, and their water supply, are in many districts scanty; habits of ablution are not cultivated, and their skin is often unclean. They live too frequently in crowded rooms, from which fresher air than they breathe is excluded. It is the same in the workshops, where the air is in many trades loaded with dust, which induces bronchitis. Workshops are sometimes ill-constructed for the supply of air for breathing, and the men themselves throw obstacles in the way of ventilation. Spirits and other stimulants are by certain numbers, such as the publicans, taken to a fatal excess. These latter causes, to some extent, account for the excess in the mortality of men over the mortality of women." Page 24.

The Death-rate for England and Wales, 1851-60, was 22·24 per 1000; for Birmingham parish, 26·51; for the Borough, 25·20. The *male* death-rate of all three in the same order was, respectively, 23·05, 28·05, 26·41. What a contrast forms the death-rate of Edgbaston—the beautiful suburban residence of the upper classes, so thinly covered with houses—with the town of Birmingham, 14·90, male and female combined, per 1000! Let us now compare Birmingham with neighbouring towns and rural districts. Dr. Farr tells us (page xxx) "that Worcestershire is healthy, and the mortality-rate was for Tenbury 17, Martley 18, Pershore 17, Droitwich 18, King's Norton 17; the rate was 23 in Stourbridge, and 23 in Worcester, where it was before 24. The fair county of Warwick had two districts in which the mortality was 18; Meriden and Solihull. The rate was 23 in Nuneaton (it had been 27), 25 in Foleshill, 25 in Coventry (it had been 27), and 27 in the Birmingham district; in Aston, including a part of the Borough, it was 21, and in King's Norton 17. Birmingham is on one of the healthiest sites in the kingdom, and is rendered insalubrious by bad local arrangements."

Among these bad "local arrangements," the first place must undoubtedly be given to density of population. It admits of no doubt that by increased accommodation, both as to houses and means of locomotion, this evil can be diminished to a very much greater extent than many persons are, at present, prepared to credit.

The actual excess of the death-rate of Birmingham Parish over that of England and Wales is, for all ages, 22 per cent.

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* Supplement to the Twenty-Fifth Annual Report of the Registrar-General of births, deaths, and marriages, 1864.

for males, and 17 per cent. for females. Nearly every age shows an excess, but it is greatest at the earliest and at the latest periods of life, another proof of the likeness of childhood and old age. Thus, under five years, the excess in Birmingham was 39 per cent. for males, 41 per cent. for females; from seventy-five to eighty-five, it was 35 per cent. for males, and 30 for females. It is hardly necessary to quote the statement of Dr. Farr, that the general mortality, without distinction of age, is to a considerable extent made up of children's deaths, and that its variation in different districts depends largely upon this element. In the healthy districts, where the general mortality was at the rate of 17·53 deaths in 1,000 living, 5·29 of the said deaths were of children under five years of age. In thirty large town districts the general mortality was at the rate of 28·01 deaths in 1,000 living; and 13·34 of the deaths were those of children under five years of age. What position does Birmingham hold when tested by the death-rate of children? Nearly the same holds good here as when I considered the question more generally, with the difference, that in this comparison Birmingham has somewhat the advantage. If compared with villages and thinly-populated towns, the death-rate of children seems terrible enough in the Midland Metropolis, but not so fearful when placed side by side with some of the London districts and certain large towns.

On page xi. of the supplement above quoted will be found tables showing the population and average annual rate of mortality per cent. of children under 5 years of age, in the 10 years 1851—60, in 28 districts where the mortality of boys at that age was below 4 per cent. At the top of the list is Bellingham, where, in 1861, there were living 420 males and 398 females under 5 years of age. The mortality for boys and girls under that age was only 2·593 per cent. for the former and 2·040 for the latter! The most populous of these 28 healthy districts, Narberth, had less than 3,000 living under 5 years of age. Here, however, the mean mortality of both sexes under that age was 3·755.

On pages xiv. and xv. there are other tables, showing the same facts in 151 districts, where the mortality of boys under 5 years of age was 7 per cent. and upwards. Birmingham stands within 21 of the bottom of this list. Looking at the magnitude of the town, and the number of cities of far inferior size below it, when this important test of salubrity is in question, the citizen of Birmingham may feel satisfied with things as they are. But the really serious matter for our consideration is, not that there are a few towns below us, but that every district in England and Wales, save 21, is above us. I append the per centages from Birmingham downwards to the bottom of the list.

	Mortality per cent. under five years of age. BOTH SEXES—(MEAN).
Birmingham	9.448
Bolton	9·495
St. Saviour St. Olive	9·618
Holborn	9·653
St. George, Southwark	9·659
Preston	9·756
Salford	9·759
Bradford	9·798
Ashton-under-Lyme	9·842
West London	9·917
Merthyr Tydvil	9.985
Sheffield	10·022
East London	10·149
Coventry	10·203
Nottingham	10·219
Whitechapel	10·246
Leeds	10·277
Wolverhampton	10·480
St. Giles	10·852
Manchester	11.725
Liverpool	13·198

These figures tell the sad story of infant mortality in large towns, and show how much the probability of life is diminished by the conditions appertaining to existence in the great centres of population. The hapless infants who come into the world amid so much misery, and who, after a brief period passed, for the most part, in pain and disease, finally leave it,—might say, indeed, in the mournful words of Pascal—"Nous ne vivons jamais, mais nous espérons de vivre."

The amount of fever prevalent in a particular locality usually indicates, with much accuracy, the hygienic state of that locality. Unfortunately, under the word "typhus" are comprised various forms of fever different in causation, different in nature, and of very different mortality. The Registrar-General is not responsible for this confusion. It lies at the door of the medical profession, among the members of which the more equal diffusion of accurate information upon this point is to be desired. It is a matter of national importance. In his table upon the annual death-rate from different causes to 10,000 males and 10,000 females living, from 1851 to 1860, Mr. Sargant assigns to the parish of Birmingham a death-rate from typhus rather above that of England and Wales, London and Bristol, but below that of Sheffield, Wolverhampton, Leeds, Liverpool, and Manchester.

Dr. Darwall* remarked in 1828 that fever "is rarely met with." He, however, expressly limits his remark to what he terms the "permanent population." "In addition to this, however," says this accomplished physician, "there is a large class of Irish, who are said to be seldom less than 5,000 in number, but who are perpetually changing. It is with these that fever mostly prevails, and their habits, morals, and condition are very far inferior to those of the native artisans. Few of them are employed in manufactories, but they become masons' labourers, or follow whatever other casual occupation they can obtain. They are badly clothed, miserably fed, and miserably lodged, and in every respect exhibit a striking contrast to their more fortunate neighbours."

This is a picture equally true to life in 1866 as in 1828. The very streets named by Dr. Darwall as the chosen seat of the Irishry, in 1828, are still their favourite quarter after the lapse of nearly forty years. From the description given of the fever which prevailed among this "changing" population, it is obvious that it was of the indigenous English type, known now as "typhoid" or "enteric fever" to the scientific observer. The true typhus, the Irish fever, *par excellence*, the disease of camps, gaols, ships, and overcrowded dwellings, is very rarely seen in this town, even among the Irish immigrants. This is a noteworthy circumstance which is not apparent in statistical *cadres*, but is very well known to the physicians in practice in the borough.

There is another disease singularly prevalent in Birmingham about which no information can be obtained from the reports of the Registrar-General, for the reason that it is very rarely the immediate cause of death; I mean tape-worm. This disorder is so common that it affects with surprise every medical man coming to the town as a stranger. Some idea of this fact can be obtained from the records of the Public Charities. The very able and elaborate report for 1865 of the General Hospital shows two cases of "Tœnia solium" among the in-patients, and no less than twenty-nine among the out-patients. The report of the General Dispensary for the same year gives twenty-three cases of "tœnia" and eleven of "vermes;" this last, including, doubtless, many cases of the former parasite. Even this gives an imperfect notion of the large amount of the malady in the town. Although the mode in which this worm gains admission into the human body, and the phases of its development while there are now a part of our certain knowledge, it is by no means clear why the citizens of Birmingham should have so exceptional a proclivity to be infested by it.

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* "Midland Medical Reporter," vol. i. p. 169. The title of the paper is "Observations on the Medical Topography of Birmingham, and the Health of the Inhabitants." Dr. Darwall died young, but not before he had shown extraordinary powers of observation and rare medical learning. His death was a serious loss to medical science, and to the town of Birmingham.

An interesting question now arises. Is the death-rate of the town at all affected by the occupations of its inhabitants? Dr. Headlam Greenhow showed in the Blue Book, published in 1858, that there was an excess of deaths from lung disease, including phthisis, among males as compared with females. This excess, taking the last disease only, amounts to no less than one-fourth. Mr. Sargant argues that, as there is a still greater excess in London and Bristol, "where the predominant occupations are altogether different," it is probably owing to some cause common to great towns. There is much weight in Mr. Sargant's argument; and the single fact that in the years 1860-61 the annual mortality per cent. of all males aged 15 years and upwards in England* was 1·816, while that of persons engaged in the iron, copper, tin, and lead manufactures was only 1·220, is sufficient to inspire doubts as to the special unhealthiness of the hardware trades. This last striking circumstance is, however, owing to the diminished ratio of deaths from 15 years of age up to 35 inclusive, among the metal-workers. A remarkable change takes place at 45, when a peculiar fatality begins to attend these men. At 45, 55, and 65 the mortality of males in England was 1·767, 3·110, and 6·625. At the same ages the mortality of males among the metal-workers was respectively 2·059, 4·009, and 9·151.

A more complete analysis of the official tables forces upon us the conviction that metal occupations must be ranked among the employments that tend, in the long run, to impair the health and diminish the probability of life. It is hardly necessary to show that grocers, shopkeepers, labourers, and carpenters have employments less conducive to disease than metal-workers. Comparison, here, too, is attended with the difficulty that many of these persons gain their livelihood in villages and small country towns. On the other hand, wool, cotton, flax, and silk operatives are for the most part resident in large towns, and exposed to conditions in other respects similar to those of the metal-workers. As the question is one vitally affecting the interests of this town, I make no apology for giving a portion of Dr. Farr's table (xxiii.) of the mortality of different occupations, for the purpose of showing clearly the relative death-rate of the most healthy and the least healthy among them. Among the last, however, I have omitted the butchers and innkeepers.

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* Supplement above quoted, page 35.

ANNUAL MORTALITY PER CENT. IN THE YEARS 1860-1861.

Years of age, 15	Years of age, 25	Years of age, 35	Occupations.	Years of age, 45	Years of age. 55	Years of age, 65	Years of age, 75
·721	·913	1·298	All England . . .	1·767	3·110	6·625	14·882
·531	·840	·923	Grocers	1·280	2·053	4·334	11·587
·474	·792	·997	Labourers . . .	1·398	2·617	5·949	15·961
·747	·910	1·203	Wool, Cotton, Flax, and Silk Manufac.	1·855	3·690	8·706	20·447
·542	·740	1·125	Metal Manufacturers	2·059	4·009	9·151	22·236

This table shows that if, at the earlier periods of life, the metal workers are actually less liable to death than the general male population, and much less liable than the wool, &c., operatives, the morbific conditions of their occupation begin to take effect at a later epoch, and act with such force up to old age, as to place their mortality per centage far above even that observed in the wool and cotton mills. The same fact comes out from another source. Dr. Farr tells us that at the ages 45-55, the mortality of London men is double that of men in the healthy districts. Now at those two ages the per centage in London is 2·468 and 4·243. In Birmingham the per centage at the same ages is 2·587 and 4·581.

Leaving Statistical Tables, and appealing to the evidence of medical observers, there is a complete unanimity of opinion as to the injurious effects upon the health of certain trades carried on in Birmingham. In his able article on the diseases of artisans in the Cyclopædia of Practical Medicine, Dr. Darwall says, justly, "the diseases which are produced by the mechanical irritation of moleculæ or fine powders are, unfortunately, numerous. The artisans who suffer from this cause are sawyers, millers, starch makers, flax dressers, horn and pearl makers; needle, edge-tool, and gun-barrel grinders; iron and brass filers, with many others. That some owe their complaints, and too frequently their deaths, to their employments, there is not the slightest question; and of these, sawyers and millers, iron and brass filers, suffer the least. Then come horn and pearl-button makers, and among the grinders it will be difficult to say which are the most afflicted. They are universally short-lived." There is a certain similarity in the symptoms of disorder, as affecting the respiratory organs, in the button makers and in the metal filers and grinders; but I believe most physicians practising in the town will yield assent to Dr. Darwall's opinion, elsewhere expressed, that a considerable difference exists in the chance of recovery. When once the grinders are attacked with their characteristic malady, the progress is in general continuous, or, at any rate, suspended only for short periods. The other class of artisans sometimes completely recover, and the progress downwards to the grave is neither so continuous nor so rapid.

Very recently a valuable contribution has been made to the Industrial Pathology of Birmingham, by Dr. Greenhow.* Several years ago Mr. Thackrah observed in his well-known essay that "the brass melters of Birmingham state their liability also to an intermittent fever, which they term the brass ague," and some French authors had drawn attention to the same facts; but Dr. Greenhow has accumulated a large amount of evidence upon the point. The disorder which affects the brassfounders is somewhat unhappily termed "ague," as there is no satisfactory proof of periodicity. It is, however, a febrile malady attended with many of the phenomena of a genuine intermittent. Dr. Greenhow states that in some establishments "almost every caster had repeatedly suffered from it." There seems no reason to doubt that the zinc employed in the brass alloy is the real cause of the disease. "The men themselves attribute it to inhaling the fumes of deflagrating zinc, or spelter, as it is more commonly called in the casting-shops, and there can be no doubt, from the facts about to be adduced that this opinion is perfectly correct, for, on the one hand, ironfounders, puddlers, furnacemen, and several other operatives, are exposed while at work to conditions exactly similar to those of the brassfounders, except the liability to inhale fumes of zinc, and yet none of these suffer from symptoms analogous to metal-ague; and, on the other hand, brassfounders suffer from this peculiar ailment in almost exact proportion to their liability to inhale these fumes." Page 9.

Japanners, lacquerers, gilders, people who employ mercury, lead, or arsenic in their work, glass-blowers, and enamellers, are also liable to special disturbances of their health. Much has been done of late years to diminish the evils attendant upon all the trades mentioned. The evil habit of intemperance seems to render the artisans more liable to be affected injuriously by their occupation than they would otherwise be. Many ingenious contrivances have been invented to obviate the effects of the more injurious employments. The shops are larger, and better ventilated. Cleanliness is indisputably more attended to among the artisans than in the times of our forefathers, and there is a constantly increasing tendency to shorten the time passed in the workshop. On the whole, I believe that most observers will be inclined to agree with Dr. Darwall, that numerous as are the evils arising from occupations, whether we consider their causation or their prevention, more depends upon the individual than upon the employment.

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* "On Brassfounders' Ague," by E. Headlam Greenhow, M.D., 1862.

Howsoever arising, the diseases and accidents occurring among the artisans and the poor are well attended to at the numerous medical institutions. These are maintained partly by annual contributions, partly by the revenue arising from investments of legacies and donations. One of the medical charities, the General Hospital, the oldest, richest, and most important in the town, is not merely known throughout the midland district for its valuable services to the community, but has a renown almost world-wide in connection with the Triennial Musical Festivals, which have been kept up for more than half a century with rare spirit, and with great advantage to the funds of the noble charity for whose benefit they were set on foot. The other Hospital in the town, for general medical cases, has been founded in our own time, and is well situated near the Edgbaston suburb, on the west side of Birmingham. Though smaller than the one first mentioned, it has conferred solid benefits on the people. The Twenty-fifth Annual Report for 1864-5 opens with the statement that the "Medical Committee congratulate the Governors on the continued salubrity of the Hospital, pyœmia and erysipelas being almost unknown in its wards." A well-informed public would see, in this remarkable statement, the most substantial ground for congratulation that could be imagined.

The General Dispensary is exclusively for home and out-patients. The scale is almost trifling compared with the great dispensaries of Liverpool. This is to be accounted for by the circumstance, that the two hospitals above-mentioned have out-patient departments of huge dimensions, while this division scarcely exists in the three Liverpool hospitals. During the last few years, another Hospital has been opened, general, so far as it embraces all diseases, with the exception of small-pox; special, so far as it is restricted to children up to the age of ten. For the purpose of giving an accurate idea of the real work done by these four, more or less, general institutions, I give extracts from the last reports of all:—

	In-patients.	*Out-patients.*
General Hospital	2,051	18,678
Queen's Hospital	1,151	12,636
Children's Hospital	612	9,184
General Dispensary	—	5,769

These figures demonstrate the ample provision made by charity for the sick and hurt in this busy town. They do not, however, comprise the whole of that provision. For many reasons, not necessary here to detail, large divisions of medical labour have fallen to the lot of institutions having special objects in view. This feature of modern civilisation has been productive of much good in many ways; and if sometimes the evils incidental to the splitting-up of General Hospitals into fractions of Hospitals have obtruded themselves rather painfully upon the public mind, the fault is perhaps more owing to the imperfections of officials than to the inherent errors of the system. Birmingham possesses a noble Eye Hospital, one of the largest and best managed in the kingdom, by means of which a very important school of ophthalmic surgery has been established. The Orthopœdic Hospital, founded still earlier, deals with deformities, and enables the poor to obtain costly apparatus, which otherwise would be denied to their slender resources. The Lying-in-Hospital, the Ear Infirmary, the Eye and Ear Hospital, of recent formation, all contribute their share to the relief of suffering, and tend, like those previously mentioned, to draw the special attention of a few professional men to certain departments of disease.

There is, however, still another Hospital in the outskirts of the Borough, not supported by the voluntary and very unequal contributions of the rich, but by the money derived from the compulsory rating of almost the whole community. This Hospital is an integral part of the Workhouse, as the last shelter of the poor is grotesquely termed in England. It is deemed right by the authorities that this vast infirmary should be under the charge of one medical officer, and there is no provision whatever, even for consultations, each one of which demands a special order. The medical attendance on the sick poor has of late engaged much attention, both in professional and general journals, and a promise of amendment has been made by the leaders of both the great parties which in succession govern the State. It is quite certain that nothing but the existence of numerous formal documents, of indisputable genuineness, will induce our descendants to believe that in the middle of the nineteenth century, when the "enthusiasm of humanity" had appeared to be at its culminating point, a rich and progressive town like Birmingham permitted an infirmary containing 599 beds to be officered by one medical man. By way of supplying precise data for the searcher into the facts of social and economic history, I here give the exact number of beds and their allocation :—

	Beds.
General Infirmary	140
Children's	26
Lock Hospital for females	31
Ditto, for males	31
Lying-in department under the management of midwife	32
Infirm and bedridden	161
Lunatic department	122
Chronic ulcerated legs	38
Consumption wards	18
Total	599

It will of course be noted that these beds are exclusive of the general department. The *total* amount of the Workhouse accommodation, exclusive of vagrant wards, was settled by the Poor-Law Board in 1865, at 1,973 beds. The sick paupers, external to the Workhouse, are under the care of six district medical officers. The number of these varies much, not merely with the amount of sickness prevailing, but with the state of trade. During the week ending the 21st of July, 1866, there were in the out-door pauper department 230 sick persons, and 29 of these were suffering from diarrhœa.

Nearly side by side with the Birmingham Workhouse, stand the great piles of buildings devoted to the detention of the borough prisoners, and the care of the lunatics. The conjunction is ominous, and tells truly the downward steps, so closely related, of poverty, crime, and madness. The trades of Birmingham are more numerous than in any single community in the history of the world. Prosperity, nearly uniform, has, for many a year, enriched her capitalists, and is ever adding new ornament to her streets. Benevolence is no longer simply a doctrine to be applauded, but a fact of daily application. How happens it that, in spite of all this, the Gaol, the Lunatic Asylum, and the Workhouse, are filled to repletion, and demand enlargement? There are two answers to this question—the defective education, and the intemperate habits of the English people. Dr. Darwall earnestly pointed out, nearly forty years ago, that intemperance was the bane of the Birmingham artisan, and the main cause of all his woes. I emphatically repeat this statement. I believe it to be an error to say that drunkenness is diminished. Police regulations are more effective; and, therefore, the evil, in a noisy form, is less obtruded by day and by night. But I appeal to the returns of the Inland Revenue, the astonishing multiplication of drinking-houses, with their infinite variety of modern fascinations, to the daily observation of employers of labour, above all to the experience of the medical men in the town, whether there is any substantial basis for the affirmation that the monster vice of excessive drinking is lessening?

I can, however, discover some excuse for the rush of the labour classes to the gin shop in their ignorance, their total voidness of soul, which seems to ask for the easy stimulus of alcohol. A grave responsibility here lies with the benevolent rich citizens of the Borough, and with the Legislature. The last will wait in vain for the assistance of fanatics, who have not themselves sufficient culture to comprehend the want. The first have hitherto forgotten, in their boundless charity, that the foremost, as it was the last, of Christian precepts is to "teach." If ever the duty of educating our neighbour is performed with the same devotion as the duty of loving him has hitherto been carried out in this country, the future historian of the "medical aspects" of Birmingham will have to recount many changes.

COFFIN-FURNITURE.

By W. C. AITKEN.

Birmingham, which does so much for us in life does not desert us in death. It hangs the bells round the coral on which we cut our milk teeth, it furnishes us with the mystic circle of the wedding-ring, and when we have "shuffled off this mortal coil" it will decorate our last cradle of elm or mahogany. "Man," says Sir Thomas Browne, "is a noble animal; splendid in ashes, and pompous in the grave." The most economical of companies in "the black business," whose advertisements appear immediately after the announcements of deaths in our newspapers, find it necessary to nail a groat's-worth of pathetic sham-finery even on a pauper's coffin.

The coffin-furniture manufacture, originally a London trade, seems to have been introduced into Birmingham about 1760, and, as has before been remarked, not improbably gave rise to the stamped brassfoundry trade, the manipulatory processes in the production of coffin-furniture in thin rolled lead, block-tin, or Britannia metal, suggesting the employment of similar methods in the treatment of brass.

Among the earliest known manufacturers of coffin-furniture in Birmingham, was one Mole, a clever workman, ambitious, like many another clever workman before and since, of becoming a master. Having determined, if possible, to introduce Birmingham goods into the London market, he borrowed a sum of money from a Mr. Webster, got up his patterns, started for London, and made his first call on the Messrs. Wagstaffe, then a celebrated town firm engaged in the trade. A strong prejudice existed in the mind of the London undertaker of the period against any article not "town-made," and the Messrs. Wagstaffe at first declined even to look at the "Brummagem" patterns. In the course of conversation, however, in which the Londoner after expatiating on the immeasurable superiority of metropolitan productions over those of the hardware village, advised the adventurous coffin-decorator to stay at home and eschew entering on a hopeless competition, Mole contrived to impress his adviser with the fact that he was no fool, and at last extorted a promise that the London gentlemen would examine the patterns if Mole would lift the box and the porter who carried it. Mole had not only a shrewd eye for business, but a strong arm for work. He placed the porter on the pattern-chest, and lifted both together on to the counter. The patterns were examined, and henceforth the Birmingham goods had a footing in the London market. Poor Mole, however, did not reap the harvest he had sown. Orders poured in upon him so fast, that Webster, foreseeing a splendid trade, put the screw on his debtor and made him bankrupt, thus securing the business for himself. Mole relapsed into the position of a workman, and died in the service of Mr. Thomas Horne, sen.,* from whose lips the writer received the narrative.

As life precedes death, an increasing population increases the demand for coffin-furniture. Manufacturers and workmen are multiplied, and the cost of production is diminished. It is strange to observe the influence of taste and fashion, and even of nationality, in the character of mortuary ornamentation. The metropolitan undertaker rejects convex or raised coffin breast-plates. He patronises not "improved" designs. He hates plates to handles, and ignores screws wherewith to fasten them so long as a nail is to be had. He abhors lace. He demands that his plates shall be of white metal. He paints not the name of the occupant on the coffin, as do our unenlightened provincial artists, but pricks it on with a punch in a series of dots on the plate, which he then smears over with black varnish. On the other hand the Celtic taste, of the green Isle of the West affects gilded ornament for the funeral chest round which the wake is held and the "keen" chanted. The Gael and Scot and half-Cymri of the West of England also participate in the desire for gilt, although the pure Cymri of Wales prefers the magpie mixture of black and white. It is only the melancholy Anglo-Saxon who chooses the sadness of unmitigated black.

The prices of coffin-furniture vary even more widely than the fashions. The pauper reposes in a coffin the mountings of which cost little more than 4*d*. a set. The well-to-do citizen demands adornments to the value of 8*s*. or 10*s*., while your landed gentleman or church-dignitary carries mountings with him to his brick-grave or family-vault, to the value of £5 or £6 sterling. Very marvellous are the designs of these adornments—these cherub-heads, bodiless but winged, though guillotined, still smiling and puffy-cheeked,—this tall damsel, trumpet in hand, about to announce the crack of doom thereon,—this disconsolate, but no less classical matron, embracing the urn over which the cypress, if indeed it be not a weeping willow, is drooping so impossibly,—these terrible pagan inverted torches, symbolic of a fire that is quenched and of nought beyond, if it be not of a fire unquenchable,—these serpents of eternity diligently engaged for ever in the mastication of their own indigestible tails,—these amorphous things that stand for the "restful poppy," or flowers emblematic of the frailty of life. Who shall tell how architecture—classical, gothic, and barbaric—has been ransacked to furnish the ornamentation of coffin breast, foot, and handle-plates? what heterogeneous hash of design has helped to disfigure the metallic lace! Beautiful, sacred, and solemn, should be even the meanest of those last offices we render to those we have loved in life. Surely there is no intrinsic necessity in this miserable desecration—no valid reason why our coffin-mountings should not bear a Christian and appropriate symbolism—why the infant span-long, youth merging into manhood or womanhood, middle age and venerable eld, should not be meetly typified in some simple touching emblem. A little care, a little thought, a little skill, is all that is required to convert these things "with shapeless sculpture decked" from a mere mockery into fitting and significant symbolism. To sink a die good in design costs but little, if any more, than a bad one; and once sunk, the cost of the article produced from it is the same. But the undertaker is like the clown in Hamlet; he "has no feeling of his business." He has to "perform the funeral," and he "performs" it, generally speaking, in a "highly-respectable" fashion.

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* The writer takes this opportunity of acknowledging the assistance he has received from this gentleman in reference to several particulars connected with the brass trade, mentioned in a previous report. Mr Horne was one of our most intelligent and enterprising manufacturers, to whose ingenuity and taste the great improvement which has taken place in the ornamentation of stamped brassfoundry is in a great measure due.

With regard to material and manufacturing processes, the ordinary metal employed for coffin-breastplates is tinned iron. When gilt or silvered, the tin is coated with size, on which the Dutch metal is laid, and lacquered or varnished over. It is then ready to receive the ornamentation which is produced by a steel or cast-iron die. The impression is given by means of a large screw press, the die being held in the "bed" by four large screws, and the "force" being fitted into the screw. Motion is communicated to the screw by turning a large cast-iron horizontally-fixed wheel. The screw with the die attached descends, and imparts to the sheet of metal a copy of the die; the number of blows required to "bring up" the pattern rarely exceeding four. Coffin handle-plates and other ornaments are similarly produced. The white coffin-lace is made from tinned metal; the black, from very thin rolled-out lead. At one period, all white lace was produced from Britannia metal or block-tin; but in 1804, one Thomas Dobbs, "a fellow of infinite jest," and of "most excellent fancy," who did "the comic business" on the boards of the Birmingham Theatre Royal, invented his "Albion metal." This "metal, akin in construction to silver plated on copper, consists of tin laid on lead, the two metals being made to cohere by passing them through rolls. This invention has recently afforded fertile ground for litigation in the celebrated "Betts' Metallic Capsule" case. Among other uses to which Dobbs considered his patent metal applicable, he mentioned the manufacture of coffin-furniture, for which it is still universally employed.*

Coffin furniture manufacturers are economical of dies. For lace, dies are sunk on square steel or iron covered with steel, each die being about sixteen inches long, by two-and-a-half or three inches wide. The Albion metal, after having been rolled very thin, is laid on the die and driven in by the "force," the surplus metal being trimmed off with a knife before the lace leaves the die. "Cutting out," or press-tools, are only exceptionally used for getting rid of the surplus metal. In the case of the coffin-plates, &c., this is effected by cutting it away with chisels. Ordinary coffin-handles are all formed of cast-iron; and a single house engaged in the trade consumes, in this branch of the manufacture alone, forty tons of iron per annum.

The usual styles are black, or white on black, the slides, &c., being left white on a black ground, or *vice versâ*. The bright varnishing black at one time formed the only usual mode of finish, but a dead black, picked out with bright, is now a favourite style. Dutch metal, of white or golden hue, has lately been greatly reduced in price, in consequence of being admitted nearly duty free. A packet which once cost 12*s*. 6*d*. can now be had for less than half the money, each packet containing 2,300 leaves.

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* Thomas Dobbs was also the inventor of one of the earliest reaping machines.

The blacking used is Pontypool varnish for the bright portions, the dead being a vegetable black ground with turpentine and a "drier." The japanning is done entirely by women, and the varnish is dried in a japanner's stove. External coffin-nails are made of cast-iron by cast-nail manufacturers, the small pins with which the lace is attached being cut in the same manner as ordinary cut-nails.

More expensive varieties of mounting are made of Britannia metal or brass, occasionally electro-plated or gilt. In these the plates are cut out of sheet or Britannia metal, or sheet brass hammered, the handles being also of brass. Occasionally a set of coffin-furniture is executed in bright brass, in the mediæval style, with the shield emblazoned, &c., at a cost of from £20 to £25. This, however, is quite an exceptional case, the friends even of lords temporal and spiritual rarely caring to incur the additional expense.

It is said that as much as from 60 to 80 tons of block tin are consumed annually in Birmingham in the manufacture of coffin-lace.

The number of workpeople employed in the manufacture has not been accurately ascertained, but it is stated, on good authority, to be about 150. The number of manufacturers is twelve. Girls are employed, who make from 3*s.* 6*d.* to 5*s.* per week. Women, as blackers, make from 10*s.* to 12*s.*, payment being made by the piece. The men, who also all work by the piece, make from 18*s.* to 20*s.*; superior workmen (who cut away the surplus metal, &c.), from 20*s.* to 25*s.* or 30*s.*; boys, "up" in the trade, from 5*s.* to 7*s.* per week.

"Coffin-furniture discount" has passed into a proverb. While the old gross prices per set have remained unchanged on the manufacturer's list, competition has advanced the discounts to such an extent that the net cost generally represents considerably less than a-third of the nominal charge. Far be it from us, however, to reveal the mysteries of the trade. The large consumer is entitled to stand on a better footing than the retailer, and the retailer than the public.

The coffin-furniture manufacture stands last in our series of reports on the industries of Birmingham and the hardware district, and thus not inappropriately ushers in

THE END.

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